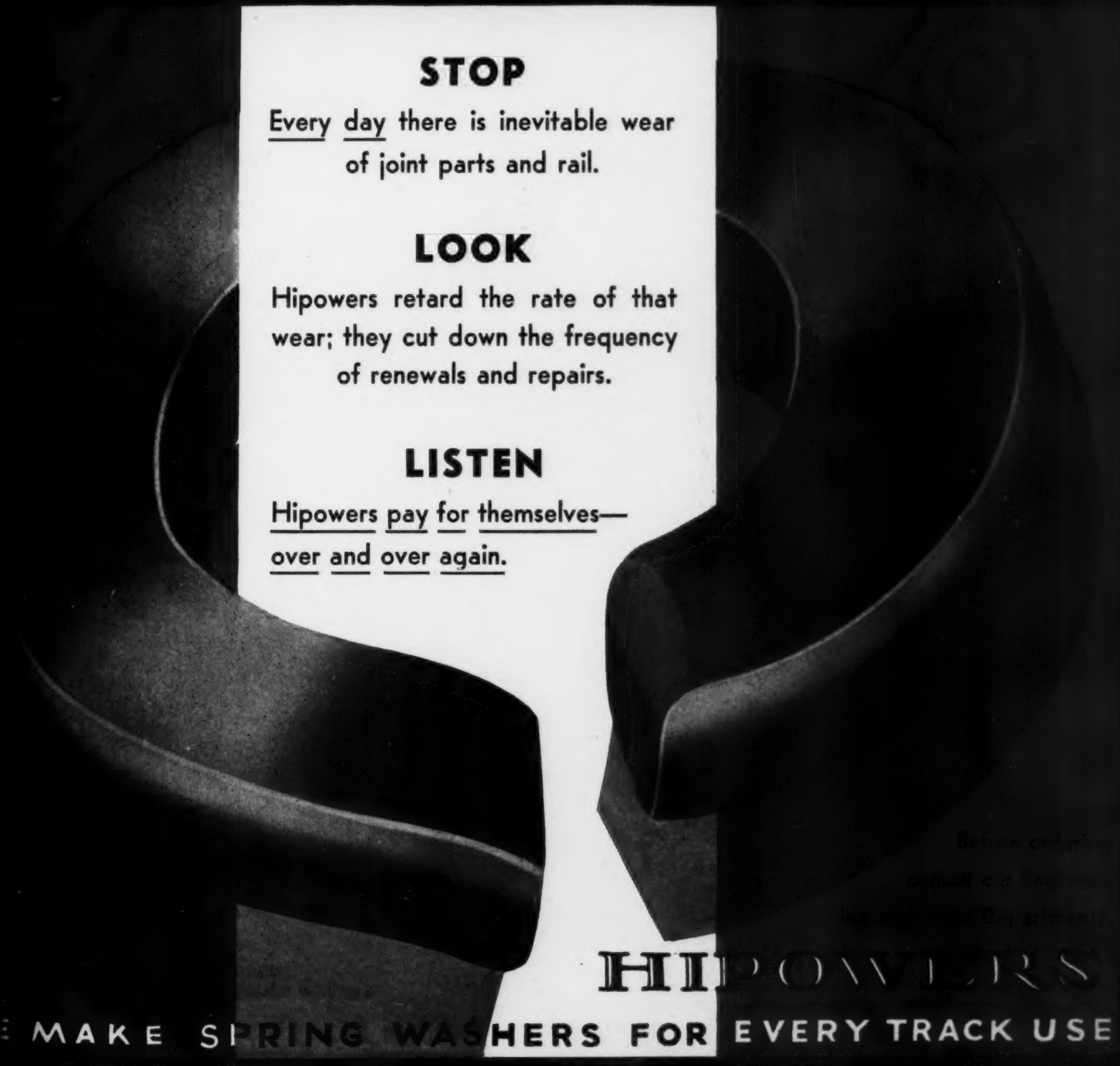
Railway Engineering and Maintenance



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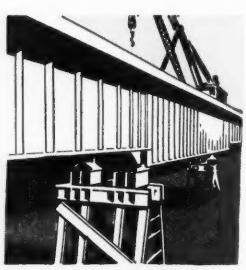
"The UNCEASING

THE frontier days of railroading are history, but there's many a job still to be done in correcting and modernizing the work of the early builders . . . in stopping that "unceasing ooze from every pore" as the eminent Wellington once described the wastes from bad railway location.

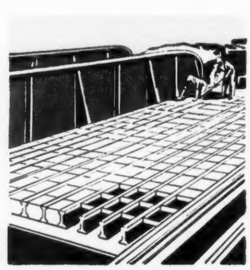
Steel has ever been the railroad's trusted weapon in combatting these wastes. This is truer today than it was a generation ago. For steel is now available in more forms, better specialized for their jobs. CB Bearing Piles I-Beam-Lok bridge floor construction, Tiger Brand Wire Rope, Keystone Rust-Resisting Sheets, and scores of other US Steel products, together with the services of the American Bridge Company, today assure the railroads of the most modern and dependable materials of construction. On each, there is information of value and importance to the engineer. Representatives of these companies are always glad to co-operate and to supply facts for your guidance.

Modern Construction

Steel structures of all classes, turntables, transmission towers and component parts • Black and galvanized sheets, automobile sheets, electrical sheets, sheets for special purposes, tin and terne plates; Keystone Rust-Resisting Copper-Steel Products; USS Stainless and Heat-Resisting Steel; USS High Tensile Steel • Wire fencing, barbed wire, wire rope, electrical wires and cables, nails, manufacturing wires, cold rolled strip steel. Springs • Concrete reinforcement • CB Sections, structural shapes, piling, plates, bars, flats, billets • Axles • Wheels • GEO Track Construction • Rails and



CB BEARING PILES
Ease of driving, faster construction, deeper penetration, and economy have characterized recent installations of these piles in railroad bridge work. There is a range of sections providing capacities for every load.



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TO RAILWAY SUPPLY MANUFACTURERS

LESS THAN THE COST OF A POSTAGE STAMP

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Advertising can cut your selling costs by acquainting your prospects with your products—arousing their interest—preparing the way for your salesmen. It eliminates "door bell ringing."

Railway Engineering and Maintenance "gets by the gate." It goes direct to the desk of the maintenance officer. It is forwarded to him on the line. It is his companion in spare moments. Is it carrying your message to him?

Maintenance Mike says: "My roadmaster loaned me his copy of Railway Engineering and Maintenance last week and I noticed that most of the materials we're using are advertised there. I wonder why."

RAILWAY ENGINEERING AND MAINTENANCE IS READ BY MAINTENANCE OFFICERS OF ALL RANKS

No. 83 of a series

Railway Engineering and Maintenance

SIMMONS-BOARDMAN PUBLISHING COMPANY

105 WEST ADAMS ST.
CHICAGO, ILL.

Subject: ASSOCIATIONS

October 31, 1935

Dear Reader:

"No, I don't believe in associations. They merely provide an excuse for junkets to committee meetings and conventions. We pay our officers to work on our railroad and that is where I expect to find them." In this cynical manner one executive officer expressed himself recently with regard to the work of various associations of railway officers. Is he correct? As Al Smith says, "let us look at the record."

So far as the engineering and maintenance of way department is concerned, association activities are confined to three associations—the American Railway Engineering Association, the Roadmasters and Maintenance of Way Association and the American Railway Bridge and Building Association. These organizations include within their membership more than 3,000 supervisory maintenance officers. More than 1,000 of them are actively engaged in committee work.

Is this work worth while? One need only review the rapid development in railway practices during recent years to appreciate the extent to which the studies of these committees are aiding in raising the practices of the individual railways to the level of the best. This is evident in the reports presented at the fiftieth annual convention of the Roadmasters Association which were published in our last issue and the reports presented at the forty-second annual convention of the Bridge and Building Association which appear in this issue. It is even more outstanding with regard to the work of the A.R.E.A.

But there is another result which I am sure that you have watched with equally keen interest. It is the effect on individuals. You and I have seen ambition awakened and latent qualities of leadership developed through participation in committee and association work that have made men more alert, better informed and, therefore, more valuable to their railways. This is a by-product of association work which is all too commonly under-estimated. No railway is stronger than its personnel. For this reason, no railway can make a better investment than by encouraging its more alert and active officers to participate in association work.

No, I believe that you share my conviction that the opinion expressed at the beginning of this letter is neither typical nor correct. However, I believe that you also share my thought that such statements puts on his mettle every railway man who is participating in association work today to do his best to place that work on the highest possible plane of service to the railways.

Yours sincerely,

Elmer T. Howson

ETH*JC Editor

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Railway Engineering and Maintenance

A Threat

To the Security of Many Communities

What happens when a railway leaves a community? This is a question which has arisen more frequently during the last few years than ever before, as one line after another has been abandoned—a trend that has already resulted in the suspension of operation on more than 17,000 miles of lines since 1917 and that reached a new high peak in 1934 when 1,995 miles were abandoned. Nor is this trend slackening, for within the last six weeks proposals have been submitted to governmental authorities contemplating the tearing up of more than 500 miles of lines of a single midwestern railway traversing some of the richest agricultural areas that exist in the entire Mississippi valley.

A Warning

Such a condition constitutes a menace to the economic security of many communities, a menace that is all too little appreciated. In an editorial in our issue for April, 1934, we discussed this subject and quoted from an editorial published in a Lincoln, Neb., newspaper relative to the abandonment of a line of the Chicago, St. Paul, Minneapolis & Omaha in northeastern Nebraska. In that editorial, this newspaper pointed in no uncertain terms to the disaster that would follow.

> "Grain elevators, lumber and coal yards will be abandoned, it said, and people will be required to haul their products greater distances to market as well as to truck in their supplies. As a result, realty and other values will decrease, thus enhancing the tax burden on other classes of property.
>
> "The principal reason why this 60-mile line has ceased to be profitable is that commercial truckers have taken away the greater part of the traffic which formerly moved over the line through competition which has been unfair because they have done hauling at prices which would not enable them to pay for their equipment and put aside sinking funds for depreciation and replacement. People want the railways when they see them vanishing but they apparently fail to appreciate them until their abandonment is threatened. Those on the Wynot line may have made some saving through the patronage of commercial trucks, but it seems inevitable that this will be far more than offset through additional taxes and greater cost, as the result of longer hauls on lumber, coal and other commodities. It was a wise man who said that you cannot eat your cake and have it too."

The Results

Eighteen months have elapsed since our editorial was written. The railway has been abandoned. What have been the results? They are set forth in an editorial which appeared in the Grain and Feed Review of Minneapolis.

> "Some 18 months ago the Omaha railroad abandoned its branch line from Sioux City, Iowa, to Wynot, Neb., a distance of about 45 or 50 miles. The line had been operated at a substantial loss for some time prior to its abandonment and because of its proximity to Sioux City most of the business which it would have normally carried was diverted to trucks.
>
> "The truckers assured the townspeople and the farmers that they would be entirely able to fill their transportation needs. They pointed out that the bulk of the transportation service was already in their hands and that they could handle what little remained.
>
> "Now let us see what has happened in this Sioux City-Wynot territory. First of all, the grain rate by rail to Sioux City and the east was three cents per hundred pounds from the farthest point on the line. Now the rate is 10 cents a bushel to Sioux City. Coal was laid down in the farthest town for 20 cents a ton, while at present truckers are offering to deliver coal to close-in points at $2 a ton. Farm values have depreciated from 50 to 75 per cent. Some farmers are 50 miles from a railroad. Homes in the towns, erected at a cost of $4,000, are begging for buyers at levels as low as $500 and there are no buyers. Lastly, the Omaha road paid $28,000 each year in taxes and this sum has been shifted over to the remaining taxpayers!"

Not a Pleasant Picture

This is not a pleasant picture. Neither is it an idle threat. It portrays a condition that is facing hundreds of other communities where farmers and merchants alike are giving to the trucks business that is essential to the continued operation of the railways. It is seldom that these farmers and merchants give any thought to the ultimate effect of the diversion of their business

from the railways on their own economic stability. Yet what has happened to the communities along the Wynot, Neb., line will happen to other communities when they too lose the railways that now serve them.

Affects Every Employee

But this problem is not alone one for the local committee to solve. It affects just as directly every employee of a railway for no line can be abandoned without depriving maintenance of way and other employees of their livelihood—and the effect is by no means confined to the lines concerned. An employee can do no more effective work in safeguarding his own position than by seeing that every present and potential patron of the railways with whom he comes in contact fully realizes the importance of giving his business to the railways as a means of protecting his own investment in the community in which he lives.

Lining in Winter

Good Line in Fall More Necessary Now

AS the use of tie plates that are fastened to the tie independently of the rail fastening increases, and it is increasing rapidly, a new problem, or rather a new phase of an old problem, is arising in connection with their use. This is the problem of lining track when the roadbed is frozen. Not many years ago, before tie plates came into use it was a comparatively easy matter to correct irregularities in line during the winter by spike lining.

While the original use of tie plates caused some inconvenience in spike lining, especially where plates with deep ribs were installed, this was largely a matter of degree. The increasing use of prebored ties and of lag screws as independent fastenings for the tie plates has introduced serious obstacles to spike lining, however, which make it desirable to avoid the practice wherever possible. These conditions have arisen so recently that many supervisors and foremen have not yet been confronted by them. It should be emphasized, therefore, that there is no insurmountable difficulty in —we may still call it spike lining—lining frozen track where tie plates of this type are installed. On the other hand, the practice is sure to cause much damage to the ties and because the progress is slow there is considerable waste of both time and material.

Modern demands for speed have already created a need for greater refinement in line and surface. This must be met by a type of track maintenance that is more nearly permanent than most of this work has been in the past. This means better workmanship, or track that is "put up to stay," as contrasted with the standard of workmanship which requires constant picking up and lining to keep the track in first-class riding condition.

For these reasons, every effort should be made to have the line as nearly perfect as possible by the time the track freezes. Obviously, this will eliminate, or at least greatly reduce, the necessity for spike lining at a later date. The demands for economy in maintenance are so insistent that no supervisor or division engineer can afford to go into the winter with track that will need lining after the roadbed is frozen. Yet with the most careful preparation, spike lining becomes necessary at times and the new method of fastening tie plates adds complications to a job that is none too desirable to start with. In view of the possibility that spike lining will be necessary, every supervisor and foreman should study the problem and be prepared to do the work with the least damage to the ties and the least expenditure of time. Yet the fact should never be lost sight of that good line is more necessary now than ever before.

Roofing

Literature on Subject Strangely Lacking

IN many respects the roof is the most important part of a building, for without a roof that will protect the occupants and contents from the weather, few buildings are usable. The railways of North America maintain more than 370,000 buildings involving more than 100 distinct types, in many styles of architecture. This great diversity in the types of buildings required to meet the widely varying demands of railway service, and the differences in design to secure architectural effects or to meet climatic conditions, create a wide range in the requirements for roofing materials.

As one measure of the importance of roofing in the railway field, the roofing that is applied to these 370,000 buildings represents an investment of more than $41,000,000 for materials alone, while the normal purchases of roofing materials for replacement and for application on new structures aggregate $5,500,000 annually. In view of this large investment, and particularly of the fact that in normal times more than 1,100,000 squares (of 100 sq. ft.) of roofing are applied annually to railway buildings, one would naturally assume that the engineering literature on roofing materials and methods of application would be voluminous.

Furthermore, it might have been expected that manufacturers would have taken sufficient interest in a market of this magnitude to have made a detailed study of the peculiar conditions surrounding the railway use of their materials, and that they would have prepared detailed instructions for their application and maintenance for the purpose of insuring the best results from the use of their products. Yet, when the Northern Pacific found it desirable to issue a manual of instructions on roofing practices to co-ordinate these practices on the various divisions on its system, it found an almost complete lack of engineering literature on the subject, while the fragmentary information that had been issued by manufacturers was of little help. Inquiry also disclosed that no other road had issued instructions on methods for applying and maintaining roofing.

Being thus thrown entirely on their own resources, the officers of the road did an exceedingly creditable job of preparing the manual on roofing practices. In fact, they are to be the more commended, because it was a pioneer effort in the field and they had no pre-

vious experience to draw on. Believing that the Manual contained information of value to all engineering officers interested in building construction and maintenance, *Railway Engineering and Maintenance* obtained permission to publish it. This has been done in a series of articles, nine in number the last of which appeared in the October issue. Each of these articles has discussed a particular material or type of roof, and given the detailed instructions contained in the Manual for its application and maintenance. That there was a widespread need for this information is indicated by the many letters that have been received from building and other officers, as well as manufacturers, containing favorable comment on the series.

Bridge Floors

Many New Developments in This Field

NO structures have been subject to more drastic changes in design and construction than highway viaducts over railway tracks. There are still in service many old structures with 12 or 14-ft. roadways, uneven plank floors, and grades of as much as 8 per cent on the approaches, with no semblance of a vertical curve where these grades join the level floor of the span across the tracks. The alinement on the highway approaches at not a few of these crossings embodies curves of 100 ft. radius or even sharper.

However, structures such as this are rarely found today on other than secondary roads. Bridges of similar design on main highways have been replaced or are now in process of replacement by structures embodying refinements in detail, heretofore deemed entirely uncalled for. Not only are these new structures stronger and wider, to accommodate heavier loads and a greater volume of traffic, but of even greater moment, they are designed to permit the movement of this traffic at far greater speeds—a consideration that has a profound influence on the standards for grade and alinement, but which has had an even greater effect on the design and construction of the floor.

Formerly, the primary consideration affecting the selection of the type of floor was cost of installation and maintenance. In other words, almost any floor that rendered good service at a reasonable cost would suffice, but today service performance is only one factor to be taken into account, for the character of the floor surface provided on a bridge has assumed an importance hitherto undreamed of. Safety to highway traffic demands that the surface be smooth, while affording adequate traction to insure effective resistance to skidding. Furthermore, the demand for the uninterrupted use of highways imposes serious obstacles to the repair or renewal of bridge floors, thus placing a premium on construction that will require a minimum of maintenance for a long time.

The imposition of these drastic requirements has given rise to a wide variety of new types of floor—some of them embodying a composite floor structure and paving surface, while others comprise a surface material to be applied over a supporting structure. Some of these new floors have been widely used while others are still in the experimental stage, but regardless of this the trend toward drastic changes or improvements in highway bridge floors is so rapid that it requires an alert mind to keep abreast of the developments. There is now a general movement to place responsibility for the maintenance of highway bridges over railway tracks where it rightly belongs—in the hands of the state highway authorities, but until this has become the universal policy, it behooves railway maintenance officers to keep posted on the requirements of adequate highway floors and the means that are employed in meeting these requirements.

Technic

Bridge Supervisor Must Have Wide Knowledge

WHILE the division officer in charge of bridge and building work is known on most roads as the bridge and building supervisor, there are still many roads on which he is designated as master carpenter or chief carpenter. These latter titles are a heritage of the days when timber played a much more important part in railway structures than it does today. True, there were mason foremen and chief iron bridge erectors in the early days, but it was primarily the carpenter foremen, because of the greater breadth of their experience, who were usually selected for advancement to "master carpenter."

Wood still is, and will continue to be, an important and indispensable construction material on the railways, but it no longer holds the dominant position it once occupied. This change has not resulted solely from the greater use of steel and concrete as primary materials of construction in bridges and buildings, but in large measure as well from the introduction of entirely new materials for many purposes in which wood formerly held the field almost alone. There was a time when slate was almost the only competitor of the wood shingle. Consider the number of materials available for roofs today!

Equally remarkable is the wide diversity of materials available for the floors of buildings and bridges, for culverts, etc. Waterproofing has developed into an art that had no counterpart a third of a century ago. The heating and ventilating of buildings have also made great strides.

Thus, while carpenter work still occupies an important role in the maintenance of bridges and buildings, it covers such a small part of the technic of the work constantly in progress on the railroads that the term "master carpenter" is a misnomer as applied to the officer who supervises these diversified operations. No more convincing demonstration of this fact is necessary than a casual perusal of the reports and papers presented at the convention of the American Railway Bridge and Building Association, which appear on other pages of this issue. The bridge supervisor of today has many responsibilities, the successful fulfillment of which calls for a detailed knowledge in many more lines than was required of his predecessors.

The New Haven's "Cedar Hill" Yard Must Be Kept Open Regardless of the Severity of the Storm

Preparing for Snow Storms

New Haven leaves no stone unturned in organization of forces and equipment to meet any storms that may reasonably be anticipated

BY reason of its realization of the serious threat of severe snow storms to train operation, and of the emergencies which such storms create for operating and maintenance of way forces, the New York, New Haven & Hartford has long considered it essential to enter the snow season as fully prepared as is possible. Already, in anticipation of the winter that is immediately ahead, all of its snowplows and flangers are ready for duty, and detailed preparations are well advanced in other respects for keeping the road open during the worst that the winter may bring. By December 1, well in advance of any probable severe weather, all forces involved in any way will have been carefully organized and keyed up to meet any situation which may arise.

Storm Conscious

The maintenance of way forces of the New Haven are snow-storm conscious. With more than a half dozen important terminals, including New York and Boston, with many important interlockings, and with more than 2,000 miles of lines carrying highly important passenger and freight traffic, including heavy commuter business in the metropolitan areas of both New York and Boston, the personnel of the road, from executive officers down to the lowest employees, realizes the seriousness of severe snow storms and accepts them not only as a problem that must be met, but as a challenge.

In the maintenance of way department, which carries the heaviest responsibility for keeping the road open during storms, the key to successful coping with winter storms is recognized as "preparedness". The men in this department recognize that after the ground is frozen it is too late to check and correct bad drainage conditions, and that when storm warnings are issued and the snow begins to accumulate, it is too late to bring together disorganized forces and equipment with hope for any degree of success. Therefore, during the fall months, all of this detail is taken care of, so that when storms come, the full weight of manpower and equipment can be put into action without a moment's delay.

In this advance consideration of winter problems, a comprehensive program of equipment and forces is drawn up on each division, based upon the programs of previous winters and taking into account any changed circumstances or conditions, and a detailed check is made of all supplies and all classes of tools and equipment used in snow-fighting operations. In the programs prepared, which are checked in the office of the engineer maintenance of way, every important unit of equipment is given a specific assignment to the end that every vulnerable point on the road is protected as adequately as possible against the most severe conditions that may be anticipated. To this advance preparation the road attributes much of its success in coping with winter conditions in the past, especially during the last two years when severe storms brought to a standstill every form of transportation except the railroad.

Snowplows Ready

The first step in preparing for winter storms on the New Haven begins in the spring, almost before the experiences of the previous winter are out of mind. At this time, all of the track-mounted units of distinctly snow-fighting equipment on the road, including 12 snowplows and 35 flanger cars, are run into the mechanical department shops for complete examination and for such repairs as may be necessary to put them in perfect condition. As these units come out, they are inspected and test-operated by representatives of the maintenance of way department, and are then stored, ready for service the following winter.

Incidentally, all of this equipment is stored under cover, out of the weather, on specially assigned tracks, and, as a precaution against the possibility of its being damaged through the handling of other cars or equipment on the same tracks, the switches of the storage tracks are spiked. When the snow season ar-

rives, these spikes may be removed, but instructions are issued that no cars are to enter upon or in any way block access to the storage tracks.

Through this arrangement for reconditioning all of the heavy snow-fighting equipment during the spring and early summer months, there is no possibility of taxed conditions in the shops later in the year interfering with the giving of proper attention to the equipment and having it in readiness. Furthermore, doing this work while any defects in the equipment are still well in mind, and then storing it clean and fully greased and oiled, results in a higher class of repair work and a higher standard of general maintenance of the equipment as a whole.

August Check-up

With the heavy strictly snow-fighting equipment safely housed in good condition by the middle of the summer, little further thought is given to winter preparation until about the first of August. At this time the annual check-up begins. Upon instructions from the engineer maintenance of way, passed down through the division engineers, each track supervisor makes a personal check of the snow-fighting equipment and supplies of each of his foremen to insure that at the proper time they will have an adequate number of serviceable snow brooms, shovels and picks on hand, and a sufficient supply of salt and snow-burning oil to meet the requirements of at least the first half of the winter. In each case, a list of the requirements is forwarded to the division engineer, who makes requisition on the stores department for the requirements of the division, with the understanding that all supplies will be delivered and in their definitely assigned locations on the different territories in advance of any possible snowfall.

At the time that the supply requirements are investigated, the foremen are instructed to give early attention to drainage conditions about culverts, switches, water columns and all other points where quick run-off is essential to proper and safe operation through the winter; the supervisor of work equipment is reminded to check the condition of all maintenance of way work equipment used in snow removal; and the plumbing forces are required to check and test all of the oil snow-melting installations on the road. All three of these assignments are considered of the greatest importance and are thoroughly complied with, with the knowledge that lack of attention to any one of them may cause serious consequences in time of storm.

The supervisor of work equipment has no jurisdiction over the conditioning of track snowplows and flangers, but must have in full readiness for snow duty the 30 cranes, 4 Jordan spreaders and 15 American ditchers on the road, as well as the tractor-mounted push plows and rotary power brooms used extensively in clearing sidewalks, platforms and driveways at stations and terminals.

The plumbing forces are not responsible for the installation of the many individually-operated snow-melting devices used at outlying points to keep switches open, but are held responsible for the working conditions of all piped oil-burning switch heater installations, and also for their continuous effective operation during storms. That this is a real responsibility is seen from the fact that 32 important points on the road are protected with oil-burnning installations piped from central sources of supply, these installations including from 15 to as many as 50 switches each. All of the installations are pressure-fed from underground tanks of 3,000 to 5,000 gal. capacity, involving the use of automatically-operated gasoline engine air pumps at points where permanent air lines are not accessible. The condition and operation of these pumps is also the definite responsibility of the plumbing forces.

No general meetings of foremen are held to discuss winter preparation and snow-fighting methods, but each supervisor is instructed to go over the entire situation with each of his foremen individually. In these personal talks, which the supervisory officers consider more effective than a general meeting because of the individual problems on each of the foremen's territories, supplies and drainage are only two of the matters gone into carefully. The snow-fighting program as it pertains to the territory is also reviewed thoroughly, not alone to adjust the assignment of men where desirable in the light of previous experience, but also to be sure that the foremen thoroughly understand their responsibilities and those of their men under storm conditions.

Review Instructions

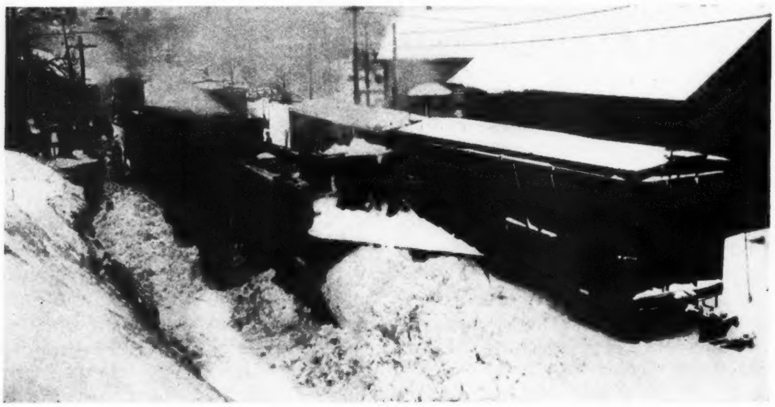
Recognizing that there is no time for discussing details after an emergency arises, this occasion is also taken advantage of to review with the foremen instructions for the handling of the extra snow-fighting forces which may be assigned to them, the keeping of special time rolls, the arrangements for feeding the different groups of men under severe storm conditions, etc. As a result of this preliminary check-up and talk with the foremen, there is no misunderstanding as to the supply and force requirements of each foreman, what is expected of him in preparing for winter conditions, and the duties of himself and his men during actual storm conditions.

While awaiting the receipt of his supplies, each foreman looks to the most vulnerable parts of his track as regards drainage, not overlooking any detail in this regard which might

Opening Up Tracks on the Boston Division at Weymouth, Mass., After Only a Few Hours Heavy Snowfall

cause operating difficulties or extra work during the winter months, and he also checks over and arranges for the installation of all of the individually-operated snow-melting devices used outside of the piped oil-burning installations. When his supplies are received, they are stored where readily accessible, in many cases at outlying points nearest the places where they will be used to avoid any possible delay in getting snow removal work started in emergency. By December 1, still well in advance of any probable snow, all of this preliminary planning and work is out of the way and everything is in readiness to meet the worst that may come.

The snow-fighting programs on the New Haven, as already stated, are drawn up on a division basis, with full responsibility for carrying them out resting upon the different division engineers. So complete and detailed are the programs, however, with every man and important unit of equipment definitely assigned to a specific piece of work, that all possibility of misunderstanding or uncertainty, and thus any chance of a breakdown or failure, is removed.



The Snowplow on the Boston Division

On the New Haven Division

Typical of the snow-fighting programs of the different divisions is that set up on the New Haven division, the largest on the road, with 1525 miles of main tracks, including the four-track, high-speed electrified territory between New Haven, Conn., and New York City. The program on this division is divided essentially in two parts. The first part lists the names and locations of all of the supervisory officers on the division who may be affected in any way by storm conditions, including the superintendent, assistant superintendent, trainmasters, yardmasters, division engineer, track, bridge and building and signal supervisors, master mechanics, and their assistants; gives the essential details concerning each of the many track-mounted units of snow-fighting equipment on the division; and includes a few general instructions to govern the actions of employees and the operation of equipment during storms.

Pilot Plows

The pilot plows are listed only by number since they are attached to road locomotives late in the fall and are kept in service position until the end of the winter, but in the case of the snowplows and flangers, the program shows their designation number, their location, the specific territory in which they are to be operated, and the names, addresses and telephone numbers of their operators.

The second part of the division program covers the detailed organization of track, bridge and building and signal department forces. Built up from schedules prepared by the individual supervisors in the light of their particular requirements and past experience, this part of the program includes the name, address and telephone number of each foreman, his specific duty in case of storm, and the assignment of his men. Through this second part of the program, therefore, copies of which are made available to the foremen, every man in the track, bridge and building and signal departments, knows the assigned location to which he is instructed to report, without special orders, in case of severe storms, and the supervisory officers of the division have a birds-eye picture of just how the various forces will function at every station, terminal, interlocking plant, yard and even outlying switch on the road.

Like most roads in snow territory, the New Haven must rely upon emergency labor to meet the demands of unusually heavy or prolonged storms. In this regard also, it leaves no stone unturned to insure that adequate emergency labor, suitably clothed and equipped for storm duty, can be made available on short notice. In outlying territory, advance arrangement is made by supervisors and foremen with men whom they know are available and reliable for snow removal work, so that these men assemble almost automatically for possible employment in case of storm. In the larger cities and terminal areas, emergency labor is secured through established employment agencies with whom the road has dealt for years and which, being familiar with the requirements of the road for such labor, can furnish it in the quantity desired on minimum notice.

As a matter of fact, during the approach and development of storms, labor is usually on hand at these agencies, awaiting call. This arrangement leaves the supervisory officers of the road unencumbered at the time of storms with the problem of rounding up additional men, seeing that they are suitably clothed, and the routine of paying them off, and with only the responsibility of fitting them into already experienced snow-fighting organizations and seeing that they produce effective work.

Feeding the Men

Even arrangements for the feeding of the men on prolonged snowstorm duty is not overlooked in the advance preparations. Where company dining car department service is available as at certain stations, arrangements can be made on short notice to provide coffee and substantial food for almost any number of men, the food being either taken out to the men while at work, or served in camp cars or other suitable quarters.

As a matter of fact, the camp dining cars of the maintenance of way department are located for the winter at all of the more important points on the line, many together with two or more bunk cars, to meet such an emergency. Where prepared food is not readily accessible to the cars, coffee and certain canned staple foods are housed in the cars continually in order to minimize provisioning after an emergency arises. At other points along the line where it is not feasible to locate company eating facilities, advance arrangement is made with nearby restau-

(Continued on page 655)

Clay and Tamping Picks—Can They Be Standardized?

This is the eleventh article of a series which began in the November issue, dealing with the number and diversity of designs for track materials and tools. In these articles the general problems of standardization have been presented, together with a discussion in detail of the effect of this multiplicity of designs for specific materials and tools, including rail, track wrenches, tie plates, lining, tamping and claw bars, rail joints, adzes, bolts and nuts, spike mauls, sledges and chisels, and track spikes, in the order named. In the next or final article, the information which has been presented will be summarized and solutions for the problems inherent in the present multiplicity of designs discussed.

THE tamping pick came into use when crushed stone began to be employed as a material for ballast about 70 years ago, while the clay pick is older than the railways, having been adapted by them for roadway maintenance early in their history. Both of these tools are relatively simple and are necessary units of the tool equipment of every track gang.

In the beginning the tamping pick was characterized by a wide diversity of designs with respect to almost every feature and dimension, including length and weight, the curve or anchor, the shape and dimensions of the tamping head, the point and the method of attaching the handle. On the other hand, there has never been such a diversity of designs for the clay pick, this tool having been more or less conventionalized from the beginning of its use by the railways.

In the earliest designs for both tools, the handle was fastened to the tool between two ribs or lugs by means of bolts or rivets, and this design persisted for many years after eyes came into general use. When eyes were introduced, a great multiplicity of designs sprang up at once, many of which were so unsatisfactory that changes in design were frequent, with the result that an individual gang sometimes required several styles of handles for the tamping and clay picks it was using.

Other features of design for tamping picks have been subject to similar changes. This is especially true with respect to the shape and dimensions of the tamping head. Some roads prefer a wide blade, others a narrow one; some want a thick blade, whereas others desire a relatively thin one; and there is equal diversity of opinion with respect to the length and outline of the tamping head.

Much of the confusion with respect to the design of tamping picks has been eliminated in recent years, since the number of designs has been greatly reduced and changes in design are not being made so frequently. Similarly the relatively less numerous variations in design of clay picks have largely been composed. Oddly, although the designs for the eye have been numerous and diverse, this feature has now been reduced to practically a single design, identical in both tools, since all but three roads accept the A.R.E.A. design for the eye.

As a result of this trend, two designs of tamping picks, including that of the A.R.E.A., and the A.R.E.A. design for the clay pick account for approximately 85 per cent of the total production of these tools today. This statement must be modified as regards the tamping pick, to the extent that a few roads which accept the A.R.E.A. design in other respects demand different tamping heads. The remaining 15 per cent of the production of clay picks represents special designs for those roads, 10 or 12 in number, which do not accept the A. R.E.A. designs. Likewise, 12 to 14 special designs of tamping picks, including 8 designs for the tamping head, make up the remaining 15 per cent of the demand for that tool.

Advance Stocks

A manufacturer can safely make up stocks of the two designs of tamping picks and of the single design of clay pick which represents the 85 per cent of his production of these tools. He is not in position, however, to stock in advance the remaining 15 per cent, representing the special designs, since any one of them may be changed without notice. Likewise, he is unable to make up advance stocks for those roads which accept the general features of the A.R.E.A. design for tamping picks, but demand tamping heads of their own design, for he has learned from experience that when a road changes its design it is extremely reluctant to accept tools of the former design, and usually refuses to do so,

although it may have been using this design for years.

As an example, a road changed its design for tamping picks preliminary to an extensive ballasting program, but failed to notify the manufacturers that it had done so. During the first two years and well into the third year of the ballasting operation several manufacturers filled large orders for tamping picks with tools of the older design. Finally, when the order for the last lot of the tools intended for their work was filled, it was discovered that the picks did not conform to the latest design and they were returned to the manufacturer.

In vain he protested that he had been given no notice of the change in design, that the road had been accepting the same picks for more than two years since the design was changed and that the order under which this lot had been made referred specifically by drawing number and date to the old design. It was of no avail, for the road steadfastly refused to accept the tools. The result was that the manufacturer was left with several dozen unsalable picks on his hands, which he still has. In addition, he was compelled to dress a new set of dies to fill the order.

Die Costs

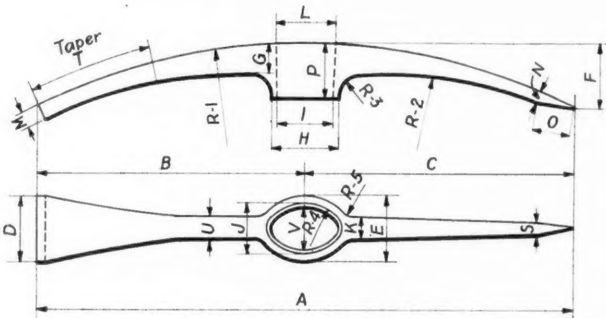
In common with other tools, dies for tamping and clay picks present a problem for the manufacturer, although this is not so aggravated here as with some of the tools that have already been discussed in this series of articles, owing to the large percentage of the production in so limited a number of designs. Drop forging dies for tamping and clay picks cost $300, including the punches and dies for the eyes. The cost of changing the shaping dies in the machines is $6 to $7.50. Dies for press forgings are more expensive, for the eye-forming set alone costs $300, while the shaping dies for tamping picks cost $250, and for clay picks $85. The cost of changing the press dies is $30, while the cost of changing the eye-forming set is the same, $14, for both processes.

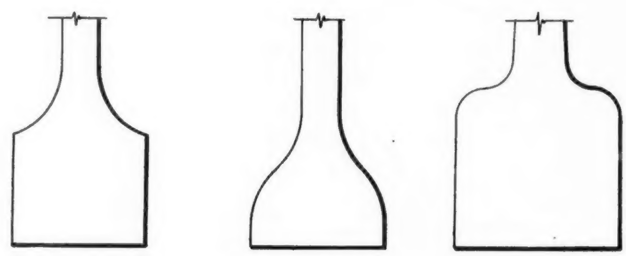
In the drop-forging process, after the eye has been formed, the ends of the picks are forged on open dies, which allows a certain amount of latitude in shaping the pick to different dimensions, so that where the differences in design are slight, a single die can sometimes be used for more than one design. In general, however, any difference in the shape or dimensions of the tamping head requires a separate die. In making press forgings, the eye is formed first, after which the two ends are shaped on dies, different dies being required for every change in design.

It should be understood that the foregoing figures represent only the actual labor cost of changing the dies when a different design of pick is to be made. They do not include any allowance for loss of production time of the machines or for the slowing down of other shop operations, the tempo of which depends on the continuous operation of the forging machines. Not unfrequently these losses are greater than the actual labor cost involved in making the change.

Since so large a proportion of the total production is in accordance with the single design for clay picks and the two designs for tamping picks, small orders do not constitute so much of a problem as they do with some other tools, for most of the orders can be filled directly from stock. On the other hand, the cost per tool for shipping and accounting is somewhat higher than for large orders. In contrast, if the order is for special tools that must be made after it is received, the cost for changing dies and the incidental loss of production may amount to more than the price of the tools.

With picks, as with other tools, when a design is changed, the old dies become obsolete, but a manufacturer cannot discard them, for he is never certain that the road will not again order the old design. As an illustration of this and of the difficulties manufacturers often encounter in filling orders for tools, a road recently ordered six picks of a design that was 30 years old, and of which the manufacturer had not made picks for





Three Designs of Tamping Head

A	26	24½	25	23¼	25	25	24	24¾	25
B	13	12	12½	11⅝	12¼	11¾	12	12¾	12½
C	13	12½	12½	11⅝	12¾	13¼	12	12	12½
D	3	3	2½	4	2½	3 3/16	2¾	3 3/16	2¾
E	3	2⅞	....	2⅞	2¾	3	2⅞	2¾	2⅞
F	2½	2⅛	....	2⅜	2⅞	2⅝	2¾	....	2¾
G	1½	1 3/16	....	1½	1 3/16	1¼	1¼	1¼	1¼
H	3⅛	3¼	....	3¼	3¾	....	3½	3½	3½
I	2¾	2¾	....	2¾	2¾	2⅞	2¾	2¾	2¾
J	2	2	2	2	2	2	2	2	2
K	1	⅞	....	1	1 3/16	⅝	1	1	1
L	3	3	3	3	3	3¼	3	3	3
M	¾	⅝	¾	¾	⅝	9/16	¾	⅝	1 9/16
N	⅝	1½	....	½	9/16	⅝	½	....	½
O	1¾	1¾	....	....	1¼	....	1	....	1
P	2½	2¾	....	2⅜	2 11/16	2½	2¾	3¼	2¾
R1	31	38½	....	28¾	....	....	....	....	30
R2	24	45⅞	....	....	....	....	....	....	....
R3	1	½	....	....	....	....	....	....	....
R4	2 9/16	1¾	....	....	....	....	....	....	....
R5	1	1	....	....	....	....	....	....	....
S	⅝	½	....	½	9/16	⅜	⅜	....	⅜
T	7	6	....	....	5	3⅛	6	4¾	6½
U	1	¾	....	1	11/16	⅝	¾	⅞	¾
V	1¾	1¾	1¾	1¾	1¾	1⅞	1¾	1¾	1¾

Variations in Nine Designs of Tamping Picks—All Dimensions in Inches

more than 15 years. This design was a special one which required a complete set of special dies, which the manufacturer still had on hand.

It was found that the finishing dies for the eye had become slightly corroded and in dressing them the depth of each was increased by 1/32 in. As a result, the overall measurement across the eye was 1/16 in. greater than the design called for. When the inspector examined them, he refused to accept them, despite the fact that the tools balanced perfectly and every other dimension was within the tolerance. To avoid making new dies, the manufacturer ground off the excess metal, but by doing so lost money on the transaction.

Tamping picks and clay picks are tools for which the specifications are relatively simple. Some roads specify open-hearth steel, others prefer alloy steel but leave the chemistry up to the manufacturer, while a few specify the chemical composition. All roads, however, specify a Brinell hardness, generally ranging from 400 to 500, at a point between 1 and 2 in. from each end of the tool.

Standardization?

In view of the reduction already made in the designs for tamping and clay picks, it would appear pertinent to inquire whether there is any reason why these tools cannot now be completely standardized. Since only three roads have not accepted the A.R.E.A. design for the eye, which is the same in both picks, there seems to be no apparent reason why these roads should not also accept it. Again, since there are no fundamental differences in the remaining features of the few special designs for clay picks and the A.R.E.A. design, and since such differences as do occur do not affect the utility of the tool, it is not clear why the A.R.E.A. design is not acceptable to the 10 or 12 roads which still insist on their own designs.

When we consider the tamping pick we find a somewhat different situation. There always has been a deep-seated preference for thick or thin and wide or narrow tamping heads, and it is quite likely that this preference will persist despite all efforts to the contrary. Furthermore, not a few maintenance officers are convinced that different kinds of ballast require different tamping heads. In fact, there are some kinds of ballast in use in which it is said that the A.R.E.A. tamping head is a complete failure. For these reasons, it is unlikely that a single design of tamping head will ever gain universal acceptance; yet it is not apparent that nine designs are necessary. From a study of these designs it appears that they could be reduced to possibly three, or at most, four and still retain all of the fundamental features of both the A.R.E.A. design and the eight special designs now demanded.

So far as the point of the tamping pick is concerned, it might be necessary to have two, or possibly three, designs to insure that tools with different tamping heads will have the proper balance, since a properly balanced tool is a matter of prime importance to the user. These variations would not increase the number of designs, since they would represent a real reduction from the 15 designs that are now being made.

Will They Accept?

Will the roads be willing to accept rigid standards for these tools? As has been shown, the number of designs for clay picks is small and the differences in these designs are of minor importance. Since these differences do not affect the utility of the tool, there should be no serious obstacle to its complete standardization, particularly since the conditions under which it is used are practically the same in every section of the country.

However, in view of the different conditions affecting the use of tamping picks, it is doubtful whether a single design for this tool is sufficient and whether, if it is insisted on, the roads will be willing to accept it. On the other hand, there is still room for a considerable reduction in the number of designs demanded by the relatively few roads that still insist on their own special designs.

Is rigid standardization necessary for economy? In view of the fact that all but a few of the roads have accepted the A.R.E.A. design for clay picks and that the remaining designs differ from it only in inconsequential details, it appears that complete standardization of this tool is the logical means whereby maximum economy in its production can be obtained.

Standardization of tamping picks has not been so nearly achieved, although the number of designs is about the same as for clay picks, owing to preferences with respect to the tamping head. If the present designs can be reduced in the manner outlined, the manufacturer will be able to effect the same economy in production that would be possible by concentrating on a single design. At the same time, if these designs are chosen with due regard to retaining all of the fundamental features of those they replace, thus providing a suitable selection to meet the diverse needs, or preferences, of the individual roads, the new designs will more readily gain universal acceptance.

Preparing for Snow Storms

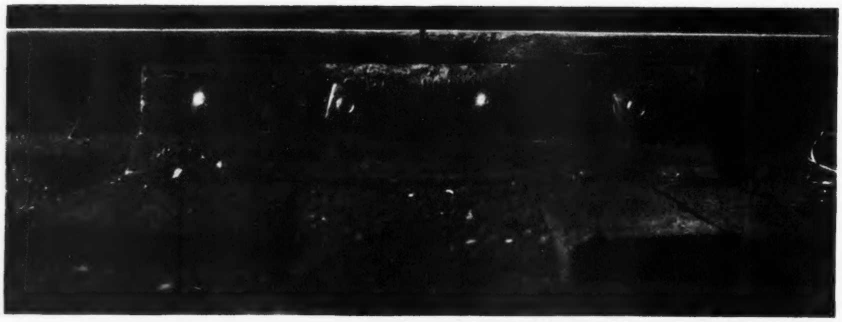
(Continued from page 652)

rants to provide for the emergency requirements of the men.

In spite of all of this advance preparation to meet winter storms, the New Haven never aims to let a storm break on it unexpectedly. Furthermore, system and division officers spread or allay alarm as promtly as information is developed, to give the field forces as clear a picture as possible of what may be expected.

Through daily weather reports, the movement of every storm area in the eastern half of the country is watched. Whenever snow begins to fall, and sometimes in advance of it, check is made directly with the local weather bureaus and with the bureau at Newark airport, New Jersey, to find out what may be expected. Furthermore, through arrangements with the maintenance of way department of the Pennsylvania railroad, the office of the engineer maintenance of way keeps advised of storm conditions over the Eastern lines of this road, which lie in the general path of most of the severe snow storms which affect New England. At the same time, the sections of its own lines remote from the general offices are alert to phone in any advance storm warnings, so that at the earliest possible moment the snow-fighting forces of the entire road can be put on their guard. If a storm actually develops, day or night, and gives any indication of a sizable snowfall, the snow-fighting organization takes form automatically, with every man at his assigned point, carrying out his assigned duty.

This latter fact is of particular importance in the New Haven's plan of action against snow storms. While it recognizes that good judgment must be used in determining when the snow-fighting organization should go into operation, bearing in mind the added cost which may be involved, it knows from experience that the cheapest and most effective way to cope with a severe storm, and the only successful way in many instances, is to keep abreast of the snowfall, which may not be possible if initial action is delayed for any reason.



A Typical Joint on the Frisco that Has Been Reconditioned by Building Up Both the Rail Ends and the Joint Bars

Frisco Combines Joint-Bar with Rail-End Welding

Starting in a small way, more as an experiment than as a definite policy, the St. Louis-San Francisco has developed an extensive program of rail and joint reclamation by oxy-acetylene welding, which will eventually include all battered rail and worn angle bars in the main tracks. The illustrations show the sequence of the various synchronized operations which have been developed on this road.

BELIEVING that the welding of the rail ends comprises, in itself, only half of the corrective measure necessary to restore the riding condition of battered joints, the St. Louis-San Francisco has added thereto, as an essential step, the building up of the joint bars by oxy-acetylene welding to give to the rebuilt rail ends the support necessary to maintain them in proper position. Furthermore, it has developed an organization which so coordinates these operations as to provide a rail-end condition approaching that of new track in its excellence, at a very moderate expenditure.

Started in 1934

The work now being done is the result of an increasing interest in rail and angle-bar reclamation, which was started in a small way as recently as March, 1934. While some welding had been done previously by several divisions, the first out-of-face welding which included the building up of the angle bars, was undertaken on 25 miles of 90-lb. rail between Sapulpa, Okla., and Tulsa. This was followed by 10 miles between Monett, Mo., and Pierce City, also on 90-rail.

Finding the results highly satisfactory, a larger program was outlined which, as now planned, will eventually include all main line rail on the system, with battered ends or worn joint fastenings. As the work has progressed, the gang organization and methods have been revised from time to time, not only to provide a balanced operation which would eliminate lost motion, but also to improve the technic of welding to insure the best grade of work of which well-trained welding operators are capable.

Among the projects now under way is the rebuilding of the rail ends and the angle bars on approximately 100 miles of 90-lb. A.S.C.E. rail between, Oklahoma City, Okla., and Sapulpa. This rail was laid at various times between 1918 and 1924, and was thus from 10 to 16 years old when the work of reconditioning was started late in 1934.

As the line is a very busy one, the rail ends were quite heavily battered and the angle bars were considerably worn. In fact, it is probable that in normal times a large part of this rail would have already been replaced with new rail because of the condition at the joints.

On this work, the welding crew consists of 12 men, including the foreman, and is assisted by a section gang of 12 men and a foreman. The welding foreman is in charge of the entire operation, the section foremen working under him while the welding gang is on their respective sections. Under an arrangement with the Oxweld Railroad Service Company, a welding instructor is provided who trains the welders, and assists in the supervision of the work. The instructor indicates the amount of rail-end welding required at each joint and constantly checks the accuracy of both the completed rail-end welding and the reconditioning of the joints.

Joints Rebuilt

Essentially, the work of this gang consists of building up the battered rail ends and of rebuilding the worn angle bars, compensating for wear on the fishing surfaces of the rail as well as on the bars themselves. In this connection, experience has shown that the wear on the fishing surfaces of the bars and rail corresponds quite closely with the batter on the rail ends. In other words, heavy rail batter is normally accompanied by correspondingly heavy wear on the angle bars.

In general, it has been found that the wear on the underside of the rail head is less than that on the top of the bar. On the average, 40 per cent of the total wear under the head occurs on the rail and 60 per cent on the bar. As a rule, the wear on the base fishing contacts is so slight that it can be neglected if the top of the bar is built up to insure a good wedging fit. Again, it has been found that the wear is relatively uniform on consecutive joints, although it may vary widely on one section of track as compared with another, the amount of wear being influenced by track conditions and the age of the rail.

The most interesting feature of the Frisco's welding program is the procedure adopted for reconditioning the angle bars, which are all rebuilt in a central field-welding yard. This yard is moved from time to time as the

work progresses and, if practicable, is located on or adjacent to a siding, at intervals of approximately five miles, thus making the maximum haul about 2½ miles, in handling both the old and the reconditioned bars.

Procedure

When the gang starts work, it is supplied with 300 pairs of new joint bars which are used to replace an equal number of old bars. The latter are then reconditioned and returned to service, releasing another lot which are in turn reconditioned, this operation being repeated indefinitely. All bars are returned to service immediately after being rebuilt, except those that are rejected as unserviceable by reason of cracks, worn bolt holes or other defects which cannot be corrected. On the average, less than three per cent of the bars are rejected as unserviceable. The deficiency created by these rejections is made up from time to time with new bars, so that a revolving supply of about 300 joint bars is always on hand. In the work under discussion, all of the joints were of the Continuous type.

The first step in the program consists in the replacement of the joints in track with others which have been rebuilt. This is done by a part of the section gang which, in the order of the work they do, consists of 1 man pulling slot spikes at the joints, 1 man squaring up nuts and assisting the bolt cutter, 1 torchman cutting off nuts, 2 men removing the joint bars, 1 man applying rust preventive to the fishing surfaces of the rail back of the joints, 2 men applying new or reconditioned joint bars, 2 men tightening bolts, 1 man full spiking and 1 section foreman.

A Welder Building up a Bar on a Jig

All nuts are cut off with a cutting blowpipe; cutting gases are supplied from cylinders carried on a small dolly running on the rail, the nuts being cut off at the rate of four in 50 sec. When applying the reconditioned joint bars, new bolts and spring washers are used, the bolts being dipped in Texaco Crater compound, and the inside of the bars being swabbed with Texas No. 45 road oil, to act as a rust preventive.

At the time the joint bars are changed, the gang corrects inequalities in expansion. After the angle bars have been applied, this advance gang also picks up and tamps all joints, to insure that the true batter will be indicated to the welding gang. It has been found that by putting the reconditioned bars on in advance of the welding and then surfacing the joints, the apparent batter is reduced by about 50 per cent. Furthermore, when the gang quits at night every joint is full bolted and spiked, all scrap picked up, and all work back of the welding gang is completed. After the entire operation on the section is completed, the section gang works over the track, oiling the outside surfaces of the joints, and gives the bolts a final tightening.

Applying the Bridge Straight Edge to Check the Height of Weld

Immediately following the application of the reconditioned joints and the surfacing, the welding instructor or, in his absence, the welding foreman, measures the length of the weld required at each joint by means of a straight edge. The limits of each weld are marked on the side of the rail head and the linear inches of weld are indicated on the joint bar, crayon being used for both purposes. In the meantime, gas cylinders have been set up on the shoulder of the roadbed at intervals of 10 joints, so connected that gas is drawn simultaneously from one oxygen and two acetylene cylinders. By reason of this spacing, a welder is able to build up five joints on each side of the group of cylinders to which he is assigned, and when he has completed this allotment of joints, he moves ahead and works from another set of cylinders that have been placed in readiness.

The Bars Are Finished by Grinding

Rail-Welding Gang

Three welders and one helper comprise the rail-welding gang, which works under a slow order of 10 miles an hour with flag protection, but does not stop trains. As the work is organized, the welders are able to work continuously except for the time required to move from joint to joint and to allow trains and motor cars to pass.

The helper handles the gas hose for the three welders, makes all connections to the gas cylinders and uncouples them when they are to be moved, keeps a record of the linear inches of welding completed each day by each of the welders and watches for trains, motor cars, etc. Because they are able to work with so little interruption, the welders are able to

complete approximately 1 in. of finished weld per minute. In fact, the average per man on this job over a long period has been 425 linear inches for an 8-hr. shift. No special heat treatment is given to the rail ends as the finished work has a hardness of 350 to 390 on the Brinell scale.

Cutting Bolts with an Oxy-Acetylene Torch

To facilitate the foregoing operations, three men from the section gang, equipped with a motor car, bring the full gas cylinders from the nearest station and set them up at the point of use and move them to the following set ups. These men also load and transport all of the old joint bars to the central welding yard and bring out and distribute for installation the new or reconditioned bars.

Grinding

Following the rail-end welders, one large Nordberg surface grinder and one smaller cross grinder of the same make have been provided to complete the third and final step in the rail-welding operation—that of grinding the welded surface and of slotting the joint.

It is common practice in rail-end welding to maintain the rail gap at all times, and on most roads the requirements in this respect are rigid. The Frisco finds that by allowing the welders to bridge this gap with the applied metal, considerable time can be saved, and it has experienced no detrimental results by reason of metal flowing between the rail ends or from other causes.

Accordingly, the surface grinding is completed before the bridge is broken, a straight edge being used frequently to insure accuracy of surface. The cross grinder is then brought into play to break the bridge and bevel the rail ends to a depth of 1/4 in. The grinding crew consists of 1 grinder and 2 helpers and is able to complete 250 joints a day.

When the bars are removed from the track, they are loaded and brought to the central bar-welding point with the motor car. Here they are sorted by the three section men who are assigned to the motor car, broken and defective bars being thrown out. As soon as the sorting is finished, the rejected bars are loaded into a scrap car which is included in the equipment of the outfit.

Taking off the old Joint Bars

In addition to this inspection, the bar welders' helper inspects the bars critically as he places them on the welding jigs, throwing out any defective bars that may have been missed during the first sorting. Finally, the welder also watches for flaws which may have escaped detection during the previous inspections.

Bent Bars

In the reclamation of the bars, those that are slightly bent are not discarded unless they contain other defects which cannot be remedied, the procedure being to straighten them, building them up to full section by applying such additional metal as may be necessary to compensate for that worn from the fishing surface of the rail.

In actual practice, the metal is added at the center of the bar to a depth of from 0.05 to 0.08 in., the film of new metal tapering each way from the center. The length of the weld ranges from 6 to 11 in., depending on the amount of wear of the bar.

After the section men have completed the sorting of the bars, they are turned over to the welders. As they are required, the welders' helper places them on jigs, which are made up of short unworn rails of the same section as that in the track. The head of the rail on the jig is cut away so that only about an inch at each end of the bar is in contact with the fishing surface of the head.

Securely Clamped

Slotted bolts and wedge keys are employed to hold the bars, which are applied in pairs, in place against the rail. This arrangement permits the bars to be put on and taken off of the jig very quickly and avoids the difficulty of working with hot bolts. The bars can be clamped very tightly by this method; in fact, if a bar is bent, it can be locked so rigidly that it will straighten when the heat of the blowpipe is applied.

Each of the four welders who are assigned to the bar-welding gang works on four jigs moving from one to the other as he completes the bars on any jig. One of the principal duties of the helper is to remove the welded bars from the jigs and replace them with unwelded bars. When beginning work on any bar, the welder first builds up the center to the required height, checking it with a bridge straight edge. He then starts at one end of the section that is to be built up and works back toward the center, repeating this for the other end.

Replacing the Worn Bars with Rebuilt Bars

The welder builds the bars a little full and as soon as the welding is completed, the helper removes them from the jig and takes them to a motor-driven grinding machine, where the sixth member of this gang grinds off the inequalities to produce a smooth even surface. This latter operation assures a better contact with the underside of the rail head than can be obtained without grinding, while the welders are not required to do so

highly finished a job as would otherwise be necessary and, as a corollary, the cost of grinding is less than that of doing the more accurate job of welding that would be necessary.

Checked Constantly

As with the rail-end work, the bar welding is checked constantly, first by the section foreman who applies the reconditioned bars, and who advises

Rail-End Welders at Work, with one Helper

the welding foreman at once of any inaccuracy of fit. The welding foreman also makes a check of the work of each of the welders at least twice a day. Finally, the work of this unit is under constant observation by the welding instructor, who is responsible for the quality and accuracy of the work.

Between Oklahoma City and Sapulpa, the joints are of low-carbon steel and are not heat treated, although some of those applied later in replacement are heat treated. When working on heat-treated bars, the welder uses his blowpipe to warm, not heat, them from top to bottom. This is done because experience has shown that bars warmed in this manner are normalized.

Rate of Welding

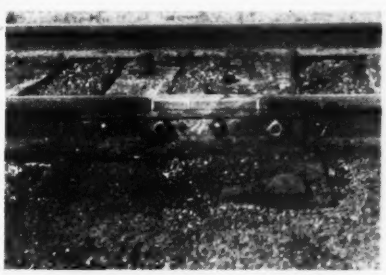
It has been found expedient to train the welders to do both rail-end work and rail-joint reconditioning, and they are moved from one task to the other as required. On the average, a welder will build up 50 pairs of joints a day and does not vary widely from this average.

However, on the other hand, the number of rail ends that can be completed in a day varies almost directly with the length of the individual welds, since the linear inches produced by each welder remains almost constant. It is for this reason that a certain amount of shifting of men from one class of work to the other has been necessary.

In general, the welding foreman works in the central yard as one of four welders engaged in joint-bar reclamation. While he devotes the largest part of his time to this phase of the work, it is not his only activity, for he supervises the entire operation, going over the work of the other units at least twice daily, to check the rail-end work, the fit of the joints as they are being applied, the surfacing of the joints and the progress that is being made by each unit in the organization. Taking the work as a whole, welding is completed at the rate of about 10 miles a month, including all delays from weather and other causes.

Well Organized

Recognizing that in a project involving a number of interdependent operations, the efficiency with which it can be carried out depends in large measure on the completeness with



An 11-in. Weld Made in 5¾ Min. The White Marks Indicate the Limits of the Weld and the Figures on the Joint Bar, Its Length. Note the Metal Bridge Across the Rail Gap, and the Smoothness of Weld.

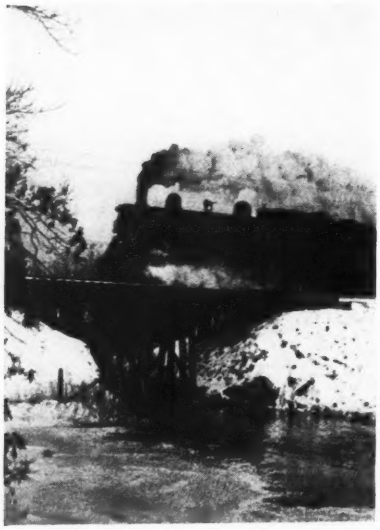
which the work of each unit is balanced with the remainder, officers of the Frisco and of the Oxweld Railroad Service Company have made special effort not only to balance the gang organization so that each unit will advance at about the same rate, but also to synchronize the work of the several units in order to minimize the possibility of lost motion, not only within the unit itself but with relation to the work of the other units. By constant attention to this feature of the work and by quickly transferring men from the bar welding to the rail-end welding when this becomes necessary, lost motion has practically been eliminated and all units go forward with clock-like regularity.

Output Increased

Careful attention to this feature of the work has resulted in a considerable increase in the total day-by-day output of the gang, as compared with that at the beginning, with a corresponding reduction in unit cost. The improvement in the riding qualities of the track are very marked and on those sections that have been completed maintenance costs have been definitely reduced. Not the least of the benefits, however, is that this rail, which according to all previous standards should have been renewed long before the welding was started on the district, has had its service life extended for an indeterminate period. Present plans contemplate that when this gang completes the work between Oklahoma City and Sapulpa, it will continue from Sapulpa to Denison, Tex., approximately 200 miles.

This work is being carried out under the general direction of F. H. Shaffer, general manager, and under the supervision of E. L. Brand, division engineer. The roadmasters are in direct charge while the gang is on their districts. L. C. Ryan, general welding supervisor, is directing the work for the Oxweld Railroad Service Company, and S. P. Donegan is welding instructor, supervising the field operation.

The Grinding of the Joints Is the Final Operation



Bridge and Building
Discuss Problems

WITH a keener appreciation of their responsibilities, a rekindled enthusiasm in their work and an expanded knowledge of current developments in the diversified fields of their employment, the 175 railway officers who attended the forty-second annual convention of the American Railway Bridge and Building Association were amply repaid for the time spent at the six busy sessions that were held on October 15, 16 and 17. The convention took place at the Hotel Stevens, Chicago, under an arrangement that provided commodious space for an exhibit by the Bridge and Building Supply Men's Association on a floor immediately above the convention hall, so that railway officers in attendance were afforded every facility for a thorough study of the excellent displays of materials and equipment pertaining to the maintenance and construction of bridges, buildings, water supply equipment and other railway service facilities.

A Full Program

The convention program was a full one, embracing seven committee reports, five technical papers and an address by G. D. Brooke, operating vice-president of the Chesapeake & Ohio and the New York, Chicago & St. Louis, at a luncheon meeting; in addition to an address of welcome by Harry G. Taylor, chairman of the Western Association of Railway Executives, and salutations from R. H. Ford and Armstrong Chinn, presidents, respectively, of the American Railway Engineering Association and the Roadmasters and Maintenance of Way Association, who were introduced in turn at the opening session by President H. I. Benjamin, vice-chairman, System Insurance committee, Southern Pacific, San Francisco, Cal.

The committee reports, which are reproduced substantially in full in the following pages, together with summaries of the spirited discussions that followed their presentation, related without exception, to current problems and recent developments pertaining to the duties and responsibilities of railway bridge and building officers. This was true also of four of the papers presented at the convention, the subjects and their authors being as follows: Recent Development in the Application of Welding to Railway Bridges, by A. R. Wilson engineer of bridges and buildings, Eastern Region, Penna., Philadelphia, Pa.; Trends in Bridge Design, Erection and Maintenance, by C. Earl Webb, division engineer, American Bridge Company, Chicago; How to Make Pile Bridges Last Longer, by I. L. Simmons, bridge engineer, Rock Island Lines, Chicago; and the Installation and Maintenance of Railroad Track Scales, by C. R. Letzkus, senior engineer inspector, Bureau of Standards, United States Department of Commerce. These papers will be published in later issues.

Of a more general nature was a paper prepared by George W. Rear, engineer of bridges, Southern Pacific System, San Francisco, Cal., and read in his absence by President Benjamin, on the San Francisco-Oakland Bay Bridge and the Golden Gate bridge; two highway structures of such extraordinary proportions that Mr. Rear's descriptions of their more spectacular features proved of intense interest to the railway men present. The former, a double-deck structure, consists of twin suspension spans connecting San Francisco with Yerba Buena Island, and a cantilever span 1,400 ft. long, with through-truss and deck-truss approaches, spanning between Yerba Buena Island and Oakland. The Golden Gate structure, which will span the entrance to San Francisco Bay, is a suspension bridge with a span of 4,200 ft. center to center of the supporting towers, the longest in the world.

At the concluding session, the following officers were elected to serve for the ensuing year: President, T. H. Strate, division engineer, C.M.St.P. & P., Chicago; first vice-president, E. C. Neville, master bridges and buildings, C.N.R., Toronto, Ont.; second vice-president, C. M. Burpee, research engineer, D. & H., Albany, N.Y.; third vice-president, F. H. Masters, assistant chief engineer, E.J. & E., Joliet, Ill.; fourth vice-president, C. A. J. Richards, master carpenter, Penna., Chicago; secretary-treasurer, C. A. Lichty, re-elected; members of the executive committee, W. R. Roof, bridge engineer, C.G.W., Chicago; T. P. Soule, general supervisor bridges and buildings, N.Y.C.,

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Bridge and Building Association

Officers 1934-1935

H. I. Benjamin, President, Vice-Chairman, System Insurance Committee, S.P., San Francisco, Cal.

T. H. Strate, First Vice-President, Division Engineer, C.M.St.P. & P., Chicago.

E. C. Neville, Second Vice-President, Bridge & Building Master, C.N.R., Toronto, Ont.

A. B. Scowden, Third Vice-President, General Bridge Inspector, B. & O., Cincinnati, Ohio.

W. R. Roof, Fourth Vice-President, Bridge Engineer, C.G.W., Chicago.

C. A. Lichty, Secretary-Treasurer, Chicago.

Executive Committee

(Terms Expire October, 1935)

C. M. Burpee, Research Engineer, D. & H., Albany, N.Y.

W. A. Batey, Bridge Inspector, U.P., Omaha, Neb.

L. C. Smith, Supervisor Bridges & Buildings, Indiana Harbor Belt, Hammond, Ind.

(Terms Expire October, 1936)

C. A. J. Richards, Master Carpenter, Pennsylvania, Chicago.

A. L. McCloy, Supervisor Bridges & Buildings, P.M., Saginaw, Mich.

R. P. Luck, Assistant Engineer, C. & N.W., Chicago.

C. S. Heritage, Past President, Bridge Engineer, K.C.S., Kansas City, Mo.

Officers of the Day

With seven committee reports, five papers, and as many addresses, in addition to active discussions from the floor, the convention of the American Railway Bridge and Building Association, which was held at the Hotel Stevens, Chicago, on October 15, 16 and 17, was an exceedingly busy one, and proved a source of inspiration and much valuable information to all those who attended the meeting.

New York; F. H. Cramer, assistant bridge engineer, C.B. & Q., Chicago.

Chicago was selected as the convention city for 1936.

The Committee on Subjects recommended the following topics for consideration by committees during the next year: Adapting Bridge Maintenance Methods to Today's Requirements for High-Speed Train Service; the Maintenance of Railway Roofs; the Relative Merits of Different Species of Wood for Timber Bridges; Protecting Steel Bridges Against Brine Drippings; the Inspection and Maintenance of Water Tanks; Underwater Repairs to Piers and Abutments; Rebuilding our Bridge and Building Organization to Meet the Demands of the Recovery Period; Recent Developments in the Preframing of Timber Bridges.

Address of H. G. Taylor

Harry G. Taylor, chairman, Western Association of Railway Executives, opened the convention with an address in which he reviewed the developments of the last year. Many problems have arisen, he said, to tax the resources of the railroads. During the last year, one road had its lines tied up at the same time by a snow blockade, a dust storm and a washout, all within 300 miles. One road had more than 200 washouts on its lines within a few weeks last spring, while washouts caused losses exceeding $2,500,000 on another railway. These, Mr. Taylor, said, illustrated the diversity and the magnitude of the problems confronting maintenance of way officers and especially those in bridge and building work. Notwithstanding this unparalleled destruction, he said, the morale of railway officers has been unbroken, with the result that the service was restored in record time, long before the highways in the same area were returned to service, many of them, in fact, being still out of service.

The railways reached their peak of traffic in 1929, with gross revenues approximating $6,280,000,000. Within three years, these revenues declined three billion dollars annually. With such a drastic falling off in business, it is not surprising that 67,000 miles of railroad are today in receivership. Yet, in spite of this dire situation and the self-evident need for assistance and relief, legislation was introduced in the last session of Congress that, if it had been passed, would have added 100 billion dollars a year to the operating expenses of the railroads. Even though this legislation was defeated, the gross revenues of the railways increased only $5,000,000 in the first seven months of 1935, whereas their expenses increased $57,000,000, practically all of which increases were beyond the control of railway managements.

H. I. Benjamin
President

In spite of these physical and financial difficulties, railway men are still looking forward. They still have faith in their industry. Railway men of past generations dared to risk colossal failure and won. This spirit of determination persists in the belief that the public will eventually give to the railways that co-operation and assistance that they need in order to render most efficient service.

Mr. Taylor concluded with a reference to the origin of the constitution of the United States and the emphasis which it placed on individual activity and individual welfare. Under this constitution, he said, we have built a country to which all of the world looks with admiration. This is a condition under which railway men have grown up. If we are true to the traditions of the past, we need have no fear of the future, he concluded.

Robert H. Ford Speaks

Robert H. Ford, president of the American Railway Engineering Association, and chairman of the Engineering Division, A.A.R., extended greetings on behalf of the association whose activities he is directing. Mr. Ford dwelt particularly on the necessity for co-ordination of the activities of the various associations in the engineering field in order that they may make a united attack on the problems confronting the railways. He stated that the Association of American Railroads had appointed a committee to survey and recommend co-ordination of the activities of these organizations.

Mr. Ford elaborated especially on the necessity for aggressive prosecution of research activities, stating that request is being made for an appropriation approximating $1,000,000 for this year. Methods are changing in all industries. Obsolescence and inadequacy are never-ending. The average life of the passenger stations of Chicago, he said, is only 35 years. Engineering research and study are needed if the railways are to keep

pace with these changing conditions. Only through co-ordinated leadership of the 15,000 engineering and maintenance of way officers can adequate progress be made. The most pressing problem confronting the railways today is the development of new methods. Do not fear to investigate new ideas, he said, no matter how visionary they may appear, for some of these ideas that appear visionary at first, prove of unquestioned merit.

Chinn Extends Greetings

I doubt if there are any two other associations as closely allied as ours, with memberships composed of men whose work is so different, said Armstrong Chinn, president of the Roadmasters' Association. It is true that there is no similarity between relaying rail and renewing the floor system of a steel bridge or between mixing concrete for an abutment and ballasting track, yet all of that work is for the one purpose of building and maintaining the roadways that carry the traffic of the finest transportation system in the world. However, in our association work, we proceed along similar lines, because we are both organized for the purpose of collecting, studying and distributing to our members the best information and knowledge obtainable pertaining to our work so we may individually perform that work in the most efficient and economical manner to the advantage of ourselves and our railroads.

These are strenuous times for the men responsible for the maintenance of our railroads. In the face of decreased earnings and lowered maintenance allotments they are asked to maintain roadways that will carry safely and comfortably the fastest schedules in the history of American railroading. That they are doing so splendidly is a fine tribute to their loyalty and to the zeal with which they are searching out ways and means of accomplishing their task. A great deal is heard these days of streamlined trains, fast schedules and record runs, but very little of the men responsible for building and maintaining the structures that make these records possible. Much of the credit for these accomplishments belongs to the members of our associations who, largely through studies and exchange of ideas in association work, are able to maintain these new standards with the funds allotted to them.

President Benjamin Sounds a Call to Action

IN HIS opening address, President Benjamin reviewed the activities of the association during last year. He then discussed the broader problems of the railways and the part which railway men should take in their solution, in part as follows:

The last five years, although trying ones, have brought about changes in methods and in service which are continuously creating new problems. These problems will continue to arise as the railroads move forward. It is our duty to study and to report upon those problems pertaining to our line of work and to be helpful to one another in solving them.

This association is composed of practical men. We are on the "spending" side of the ledger, although much of our work results in the conservation of revenue, which is just as important. So it behooves each one of us to lay out and perform the work he is called upon to do in the most efficient and economical manner consistent with safety.

We have learned much during the last five years in ways to prolong the life of many of our structures. The reduction in expenditures for maintenance work for which bridge and building men are responsible from $130,849,000 in 1930, the last normal year of railroad operation, to $57,770,000 in 1933, means that the time is rapidly approaching which will necessitate heavy maintenance work if properties are to be restored to their pre-depression condition. We should be prepared to do this work and should be formulating plans and methods which will give the most economical results.

The prosperity of the entire country is dependent to a large extent upon the prosperity of the railroads. The public, as a whole, has little appreciation of this and even many railroad men do not fully realize the truth of this statement.

One half of these expenditures go for materials and the balance for salaries and wages. In normal times the railroads consume 25 per cent of all the coal mined, 16 per cent of all the steel fabricated and 16 per cent of all the lumber produced. Because the railroads do not confine their purchases to a relatively small number of producers, industries not only suffer but curtailment of production must generally follow when this consumption is reduced. This shrinkage of purchasing power is felt in many communities throughout the land.

Employment Declines

With reference to wages, in 1930, 1,487,839 men were employed, with salaries and wages totaling $2,224,500,000. In 1933 the total number of employees had declined to 971,200 and their income from salaries and wages had shrunk to $1,199,600,000. In 1934, although detailed figures are not available, not more than 1,000,000 persons were employed, with a combined income of not more than $1,250,000,000.

A railroad man is seldom able to retire on his savings and investments. Therefore, the huge sum of money represented by wages and salaries is purchasing power. It helps keep the wheels of progress and prosperity turning. The local merchant is hard hit, manufacturers suffer losses and the unemployment problem becomes acute when this buying power is curtailed.

The railroads are the most regulated industry in the United States. They are suffering from too much regulation. There is no major phase of railroad operation that is entirely free from some form of federal or state control or restriction.

If regulation were carried into all fields of transportation endeavor, the situation would not be so serious. Motor buses and trucks, not hampered by government regulations, operate over highways paralleling railroad rights of way, built in part from funds taken from the railroads in the form of taxes. Waterways are made navigable at public expense, again with the railroad as a contributor, and are used by government-subsidized carriers.

The railroad industry in the United States represents a capital investment of about $26,000,000,000. Fast and economical service must be and has been maintained. Rolling stock and locomotives must be purchased and large sums must be expended for air conditioning of passenger equipment, for new high-speed streamlined passenger trains and for other improvements. Where is this money coming from? To secure this capital the plant must earn a fair return or it will be impossible to proceed far with any

of these activities. All the railways are asking is an even break, that in competition with other carriers they be given equal treatment under the law, that they be not taxed to provide assistance to competing carriers of transportation, that this taxation be on a more equitable basis, and that the subsidizing of other forms of transportation be withdrawn.

Government ownership of railroads is considered by some as a solution to the problem. But what would this solution involve? Will state and local communities be satisfied in having their incomes reduced by the $1,000,000 per day that the railroads pay in taxes, without forcing other industries and individuals to make up this loss?

Private enterprise survives by the results which are obtained, while government enterprise survives through taxation. A government owned or operated railroad has seldom developed an improvement. Compare this with the initiative of privately owned railroads that is developing the high speed train, that is improving refrigerator service, that is establishing store-door pick-up and delivery service. No, government ownership, no matter how widely it may be advocated by the unthinking man, will not solve the problem.

Members of this association may well ask what they, as citizens and as railroad men, can do to put on its feet once more the largest and most necessary industry in the country. One million railroad men, scattered in every nook and cranny of our country, not only control many votes but have much influence in their communities. Railroad men must pull together for as the railroads prosper, so does the railway employee prosper.

Being in supervisory positions, bridge and building men travel over their territories frequently. On these travels they eat at many restaurants and spend their nights at many hotels. Their patronage is wanted by the restaurant man, by the hotel keeper, by the butcher, the baker and the local merchant. Would you sit idly by and let a trestle burn, if you could save it by a little effort on your part? Do you, as railroad men, want government ownership with its spoils system and its politics? Many of you have come up from the ranks and know that promotion is based on merit.

It is unfortunate that there is no opportunity for a systematic educational campaign to put the railroads' side of the picture before the public. This is your duty. Get acquainted with your elected representatives, county, state and federal. Get acquainted with the public with whom you come in contact. Show them that your prosperity is their prosperity, for when the pocket book is hurt, it is deeply felt. You can do a world of good and your officers will give you every help possible. If you had a washout or a burnout to repair, you would know what to do. The present crisis is as serious in its way as any interruption of traffic you will ever have to remedy.

Many of you may say that it cannot be done. I say it has been done and can be done again. Dangerous legislation has been killed by active work on the part of railroad men and what has once been done can be repeated. You have a job to perform. You have never failed in an emergency and I cannot see how you can fail in this if you realize the seriousness of what is taking place.

G. D. Brooke Speaks at Luncheon

AT A luncheon on October 16, which was attended by some 175 railway and supply men, including several operating and executive officers, George D. Brooke, operating vice-president of the Chesapeake & Ohio line and the New York, Chicago & St. Louis spoke on the importance of leadership. His remarks were in part as follows:

The maintenance organizations of our American Railroads are made up of a fine body of men. They take great pride in building and maintaining smooth, neat track and strong, safe bridges, substantial buildings, efficient signals and water stations. They are ready to work long hours when necessary and to exercise unceasing vigilance to promote the safety and continuous operation of the railroad. They are ever willing to go out in storms and rough weather to look for washouts, land slides and other interruptions to train movement and to meet emergencies when they come with energetic action. Bridge and building men especially seem to glory in emergency jobs, in working under high pressure to rebuild trestles, to crib up track on washed embankments, to rebuild important buildings and to meet emergency situations quickly and efficiently.

G. D. Brooke

It has been my experience that bridge and building men are very ingenious in meeting special problems of construction and maintenance and if encouraged are frequently able to develop methods which effect marked savings in time and cost. All of you realize the necessity of exercising much care in planning jobs which, while more or less routine, are nevertheless unusual, as for example the dismantling of a bridge. Here the procedure is much the reverse of that of erecting the structure and therein lies the unusual nature of the job. I will relate an incident which occurred a few years ago.

A trestle on an abandoned branch line was being torn down. The work was in charge of a bridge foreman of many years experience and considered one of the best men on the road. A car with a light crane had been placed on the trestle on which to load the material from the bents which had already been dismantled. The foreman and one or two men were on the ground, but most of the men were up on the trestle. Piece by piece the braces were removed until suddenly the trestle folded up like a jack knife, carrying the car and the men with it to the ground, injuring all of the men involved—some of them very seriously.

If this foreman had been erecting the bridge instead of tearing it down he would never have run a car out on the bridge in the condition it was at the time of the accident, but would have seen that it was well braced and safe in this respect before subjecting it to a load. Yet, when the process

was reversed he failed to realize the importance of removing the car before proceeding so far in taking down the braces and other essential members of the bridge. I mention this to impress upon you bridge and building supervisors the importance of checking the methods of your foremen where unusual work is to be performed to see that there will be no question as to their plans being sound and well within the bounds of safety.

The problems of railroad management have been particularly serious and pressing during the past few years. Earnings have been far from adequate to meet actual needs. It has been necessary to make the available resources go just as far as practicable and funds for maintenance work have accordingly been curtailed. In circumstances of this kind, maintenance officers can handle their work most successfully and can be most useful to the railroads which they serve by having a sympathetic understanding of the point of view of the management and meeting their problems and planning the work from that viewpoint. Of greatest importance, of course, in situations of this kind, is the guarding against unsafe conditions, and the repair of structures to prevent them from becoming unsafe. On the other hand, it may be found that structures which under normal conditions would be renewed, can, by careful watching, be continued in service.

Electric welding is a great aid in repairing defective details of steel structures and through its use the strength of important members can be so increased as to prolong the usefulness of a structure indefinitely. Frequent and careful inspections are doubly important under such circumstances and bridge and building supervisors should not depend entirely upon others for this essential work, but should make periodic inspections with a frequency that will insure a reliable personal knowledge of the bridges and structures which require this careful watching.

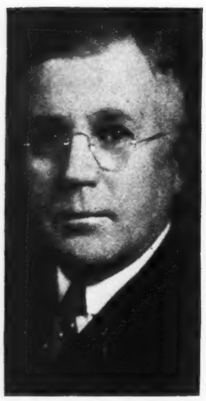
Next in importance are those conditions which, if permitted to continue, will ultimately result either in the structure becoming unsafe or in heavy expenditures for renewals. The protection of steel structures from corrosion is an outstanding example of this. Unprotected steel, where subjected to the action of locomotive stack gases, will deteriorate with alarming rapidity. Spot painting can be done to good advantage, but when full painting is really needed it should not be deferred.

With the advent of the better times to which we all look forward, funds for maintenance purposes will be more liberal, but you will still have interesting problems. You will find it important to utilize methods and materials which will reduce future maintenance costs to the minimum. The use of treated timbers, of better grades of paints with increased life for metal protection, the framing of bridge timbers before treatment have advantages which I am sure you all realize. In clearing up any bad situation, as for example, one resulting from deferred maintenance, I have found it advisable to correct first that condition which is most troublesome and the remedying of which will give the greatest returns in operating economies or in the reduction of current maintenance expenditures, so as to release funds for other maintenance needs. The correction of the next most difficult condition should then be undertaken and so on in order. The results of this method of attack will be surprisingly gratifying and comforting.

Unfortunately, railroad men have in the past had reputations for being arbitrary and of thinking too little of the feelings and rights of those with whom they deal, whether they be employes, shippers or neighbors along the right of way. In recent years there has been a great improvement in this respect and we have now reached the time where such spirit and attitude are entirely out of place. In all of our business relations, patience, tolerance and tact are essential. If our position is sound, we should be able to convince the other party to any dealings of that, or at least of our intention to be fair and reasonable. We should so conduct ourselves as to make friends for our railroad and the railroad industry.

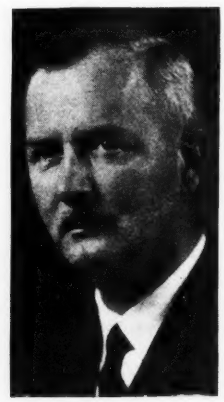
In our study of problems, we should always assume the attitude of openmindedness. It is a human characteristic to think well of practices for which we are responsible or which we have followed for a long time, but to get the best results we must consider suggestions fairly and endeavor to adapt them to our practice or to modify our methods so as to embody any improvements which may be practicable.

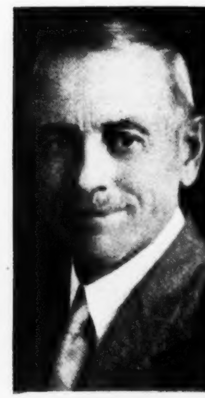
We are in the midst of a period of transition in the transportation industry. Efficient motor vehicles on improved highways provided by national and state governments, waterways also provided by a beneficient government, and airways have cut heavily into railroad transportation. The problem of the railways in these circumstances is to adapt themselves to the changed conditions. It is folly, I believe, not to recognize the motor vehicle as an economical means for handling a great deal of the local short haul transportation. Federal and state control of highway transportation will gradually stabilize


T. H. Strate
First Vice-President


E. C. Neville
Second Vice-President


A. B. Scowden
Third Vice-President


W. R. Roof
Fourth Vice-President


C. A. Lichty
Secretary-Treasurer

trucking rates. The railroads can then determine to what extent their rates can be reduced to meet trucking competition and in this way the economical radius of trucking operations will be determined for various classes of freight under varying conditions. It is our job to meet conditions with ready adaptation and to provide the best railroad transportation that is humanly practicable.

You assembled here are the leaders and directors of the railway bridge and building men of our country. Most of you have risen from the ranks of bridge and building gangs. You are proud of the traditions of these men and are anxious that they continue to be lived up to. Your position of leadership gives you great opportunities to foster this spirit and to develop future leaders to follow in your footsteps and to build even better than you. We fail to realize how strong our personal influence upon others really is, and how great are our opportunities for aiding the development of the younger generation. There is no greater pleasure than to see strong sound young men growing up to succeed us and to feel that we are in some measure responsible for their being what they are.

Cleaning Steel Bridges

Preparatory to Repainting

Report of Committee

THE cleaning of steel bridges preparatory to repainting is a subject in which all bridge and building maintenance officers are vitally interested because it represents an expenditure far in excess of that required for the application of the paint for which the cleaning was done. Experience in the maintenance of steel bridges has proved the necessity for thoroughly cleaning the surfaces before applying paint in order to provide perfect contact between the metal and the paint film and between the various coats of paint. No paint can give satisfactory protection to the metal if it applied to poorly-cleaned surfaces.

Newly fabricated bridges must be cleaned of dirt, grease and loose scale before the first coat of paint, generally termed the shop coat, is applied. Dirt and grease are easily removed and loose scale requires only reasonable attention and care, but the shop coat, being the foundation paint coat, must be of good material and properly applied if the desired results are to be obtained.

A Growing Practice

A growing practice that is designed to clean the new metal more thoroughly is to allow it to take on a slight rust coat that tends to loosen more of the mill scale, and then sandblast the surfaces to a gun-metal finish before the first coat is applied. This additional handling and the expense of sandblasting adds greatly to the cost, and it is questionable if the expense is justified except in locations where rust conditions are severe.

Much can be done in the design of a bridge to lessen the cost of painting and to facilitate the application of additional coats in a proper manner, after erection. It is important that no members be so designed or placed that proper inspection, cleaning and painting cannot be performed after the bridge is in service. Many structures have deteriorated badly and have been removed prematurely from service because of the impossibility of providing proper paint protection to various parts because of poor design. In locations where rust conditions are severe, the necessity for care in design is particularly important.

E. C. Neville
Chairman

Bridges in service require not only the cleaning off of dirt, grease and oil, but in addition the cleaning of all rust spots or areas to the bare metal so thoroughly that rusting will not continue under the new paint. The removal of rust or corrosion is difficult in proportion to the amount of deterioration that has taken place, and as all paint coats are removed from such areas when this rust or corrosion is cleaned off, it is necessary to build up the paint again from the bare metal.

It is more economical to do the painting before the existing paint actually breaks, as one (or possibly two) additional coats applied to the old paint will restore its condition and avoid the cost of cleaning the surface of the metal and build up the paint coats. While this is a condition not likely to be attained in regular maintenance, the nearer it can be met, the less costly it will be and the better will be the result. A modern steel structure painted frequently enough to avoid any loss of metal due to rust, will last forever, whereas neglect may easily result in rapid deterioration and premature retirement of the structure.

The methods and the cost of cleaning depend upon the condition of the structure, and range from the wire brushing of a few spots to the sandblasting of the entire structure. There are a number of causes for the rapid destruction of the paint and the early appearance of rust. Among them are salt air from the ocean, fumes from manufacturing plants, gases from locomotives, brine drippings from refrigerator cars, poor paint, and poor application of good paint. If the cleaning can be done as soon as rust spots begin to appear, hand scrapers and wire brushes are suitable, and the work of cleaning is moderate in cost.

A consistent program of spot cleaning and spot painting will prevent deterioration for a considerable length of time, although this practice may not be as economical as a full paint job at the proper time. Due to local causes, such as brine drippings, etc., certain parts of a structure show signs of rust much sooner than others and these parts should be cleaned and painted not only more frequently but also before there is any actual loss of metal.

It is not good practice to permit a bridge that is to be retained in service to become so badly rusted that excessive cleaning is necessary, because there is always a loss of metal from corrosion and because of the difficulty of preparing and repairing such a

badly rusted structure so that it will be in as good condition after painting as when it was new. Structures that are to be removed for other reasons may be allowed to become somewhat rusty without serious loss of strength or service.

It is the custom to estimate the cost of cleaning and painting bridges in terms of weight, i.e., by the ton of metal in the structure. This would be a satisfactory unit if the areas of surface for different types of spans were the same per ton of weight. Surfaces vary greatly, ranging from 75 to 150 sq. ft. per ton for ordinary railroad bridges, but as the ton price is well established, estimates and records of the cost of cleaning will be given in that unit.

The usual tools used for cleaning steel structures are:

1. Hand tools consisting of (a) chipping hammers, (b) scrapers and (c) wire brushes.
2. Pneumatic tools consisting of (a) rotary wire brushes, (b) pneumatic chipping hammers, (c) pneumatic scaling hammers and (d) scaling tools.
3. Sand Blasting.

The chipping hammer for hand cleaning is about six inches long, with two chisel striking faces, one at right angles to the handle and the other on a line with the handle. Scrapers are usually made from large discarded files or rasps, both ends being sharpened chisel fashion with one end straight and the other bent at about a right angle. Wire brushes are of the ordinary wood back, scrub-brush type. A narrower brush, with a handle something like a shoe brush, is also used for cleaning around rivets and getting into corners.

Pneumatic wire brushes are rotary tools equipped with a brush usually made from small wire rope, the ends of which tear the old paint and rust from the metal. Brushes of this type usually revolve at high speed. Slower speed is more effective in removing old paint, but the speed is not important when removing rust. Pneumatic chipping and scaling hammers operate by chipping or cutting the old paint and rusted parts. Pneumatic scaling tools clean the metal by rapid light hammer blows. The type to be used depends upon the condition of the metal to be cleaned.

When a bridge or parts of it become too badly rusted or pitted to be cleaned readily and effectively by chipping or scraping, the sand-blast is the only effective method of securing a satisfactory clean surface for repainting. This method is, however, the most costly. Proper maintenance should never permit a bridge to get in a condition where complete sand blasting is required. A sand-blast cleaning costs many times more than repainting at the proper time. The cost of cleaning with a sand-blast depends upon the size of the areas to be cleaned and the percentage of the total area so cleaned, although there are certain charges such as setting up the plant that are not entirely dependent upon the size of the job. Occasionally it is somewhat less costly to clean rusted surfaces by sand blasting than it is to remove old paint coats, especially those of tar or asphalt type.

One of the first requirements for a sand-blast job is to select the proper grade and quality of sand to be used. A few railroads report the use of any sand that can ordinarily be obtained locally, some even using engine sand. Good results cannot be expected if good clean, sharp sand is not used. This is clearly proved by a test made in 1934 by the Canadian National, when three different sands were used, all of which had been selected and recommended especially for sand blasting. The results were:

	Average Time to Clean One Square Foot
Sand No. 1—River sand	2.8 min.
Sand No. 2—Pit sand	4.5 min.
Sand No. 3—Crushed quartz	1.5 min.

A further test was made to compare another sand with crushed quartz, using a 5/16 in. dia. nozzle and an air pressure of 80 lb. at the machine:

Sand No. 4—Used 222 lb. to clean an area of 2,341 sq. in. in 14.25 min., or 13.65 lb. of sand per sq. ft. in 0.88 min.

Crushed Quartz—Used 205.5 lb. to clean an area of 3,139 sq. in. in 12.25 min., or 9.43 lb. of sand per sq. ft. in 0.56 min.

Crushed quartz shows a saving of 31 per cent in weight and 37 per cent in time over the other material.

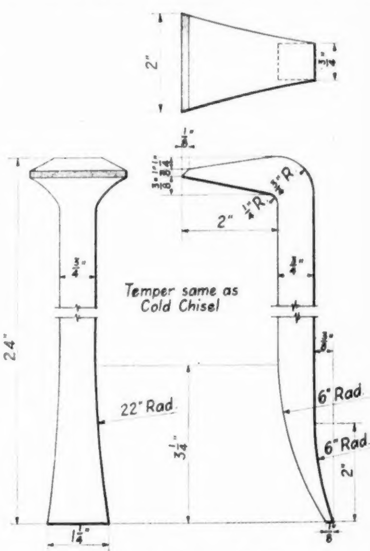
It must be noted in these cases that the steel was cleaned to a condition suitable for the application of spray metalizing, which accounts for the large amount of sand used per square foot. In cleaning for a normal paint job, the consumption of sand would be somewhat less.

Another important requirement is that the orifice in the nozzle be maintained at a size suitable for the capacity of the compressor and the nature of the work. Nozzles with hard linings, while high in price, are efficient and soon save their greater cost in more effective work and in reduced air consumption. As many nozzles should be used as the capacity of the compressor will permit. This will cut down the overhead costs of setting up and operating the compressor, etc. The size of nozzle most generally used is 5/16 in. dia. and this size requires about 134 cu. ft. of air per min. at 80 lb. pressure. It will discharge about 1,250 lb. of sand per hour. A smaller nozzle will use less air but will also do less work and a larger opening will use too much air for portable plants. The usual nozzle of malleable iron is inefficient, as the orifice soon increases with a resulting loss of pressure, or waste of air.

The loss of sand blasting efficiency due to enlarging of the orifice with wear is shown in the following table:

Dia. of Orifice Inches	Air Discharged 80 lb. Pressure Cubic Feet	Sand Delivered Per Hour Pounds
1/4	85	900
5/16	134	1,250
3/8	193	1,700
1/2	343	3,000

From the above it will be noted that a very slight enlargement of the nozzle orifice will quickly reduce the air pressure or will require a much greater volume of air. As an example, a 1/4-in. orifice worn until it becomes 3/8-in. diameter, reduces the pressure from 80 lb. to 30 lb., and if enlarged to 1/2 in. the pressure will be reduced to 10 lb.



Painters' Rust Chisel

The amount of surface that can be cleaned with a sand-blast depends upon the abrasive material used, the condition of the surface to be cleaned and the extent to which it is desired to clean the surface. The usual requirement is that the metal shall be sand-blasted to a gun-metal finish but there seems to be a growing belief that some lesser degree of cleaning is preferable in order not to have a polished "oily" surface upon which the first coat of paint is to be applied.

On ordinary bridges, the best results are obtained by a plant consisting of a gasoline-driven compressor with a capacity of from 160 to 210 cu. ft. of air per minute at from 80 to 100

lb. pressure at the machine; one sand-blast machine of at least 6 cu. ft. capacity, the necessary air line, sand discharge hose and nozzles. The air line from the compressor should vary in size, according to the length of the line. A 1¼-in. line will give good results up to a distance of 150 ft., but for greater lengths this should be increased to from 2 to 3 in., depending upon the length of the line.

Must Remove Moisture

A moisture eliminator should be installed in the line to remove the moisture from the air before it enters the sand tank to prevent the sand from getting moist and clogging the outlet valve of the sand machine. The longer the air line is, the more the moisture to be expected; the installation of two or more eliminators will add to the efficiency of the plant. Steel tanks of 50 to 100 gal. capacity installed in the line, with drip cocks to drain off the accumulated moisture, are a great advantage in the absence of rotary eliminators, although the latter are much more efficient.

Not less than a 1-in. hose should be used for the sand discharge line when the nozzle has a ¼ in. or 5/16 in. orifice. In addition, it is essential for the nozzle operator to be equipped with a sand mask or hood that comes well down to his shoulders, with a ¼-in. air hose entering the hood at the back of the head, the hose to be equipped with a small valve so that the operator can regulate the amount of air required to dispel the dust from the hood.

A vision glass about 2 in. wide and 10 in. long is provided in the front of the hood, and a quantity of spare glasses should be kept on hand, as it is necessary to change them frequently because the rebound of the sand mars the surface and obscures the operator's vision so that he cannot see the condition of the work distinctly. It is also obvious that obscure vision is not conducive to safety while working on scaffolding.

Scaffolding

Scaffolding for sand-blast work should be of a substantial nature. It should always be provided with a railing or guard rope to protect the operator from falling off, the weight of the sand hose under pressure being an added hazard. It is also necessary to protect the ropes and tackle lines supporting swinging scaffolds from being damaged by the rebounding sand, as otherwise they may soon be destroyed. This is done by wrapping them with canvas or old bagging.

The cost of cleaning depends upon the amount to be done and varies from a nominal sum to a record of $17.50 per ton of metal. One railroad reports the following costs, taken from records covering a large number of bridges that were repainted before their condition became bad enough to require excessive cleaning. They represent the cost of preparing the metal for painting at about the most practical time that such work should be done, or just after the old paint began to show many breaks.

Type	Weight	Cost per ton of steel
150 ft. through trusses	317 tons	$0.65
140 ft. through trusses	301 "	.60
300 ft. through trusses	1,101 "	.30
150 ft. deck trusses	308 "	.95
200 ft. through trusses	345 "	.55
200 ft. through trusses	934 "	.35
Viaduct	475 "	1.00
400 ft. through trusses	538 "	.60
180 ft. through trusses	967 "	1.05*
Through plate girders	281 "	1.15
Various	2,805 "	1.35†

*Close to ocean.
†Over salt water.

All of the above work was done by hand, except on the last structure which consisted of trusses of various lengths and a truss swing span; pneumatic tools were used in the cleaning.

From records of a large number of bridges of various sizes and types, another railroad reports the following average costs of cleaning, using hand scrapers and wire brushes:

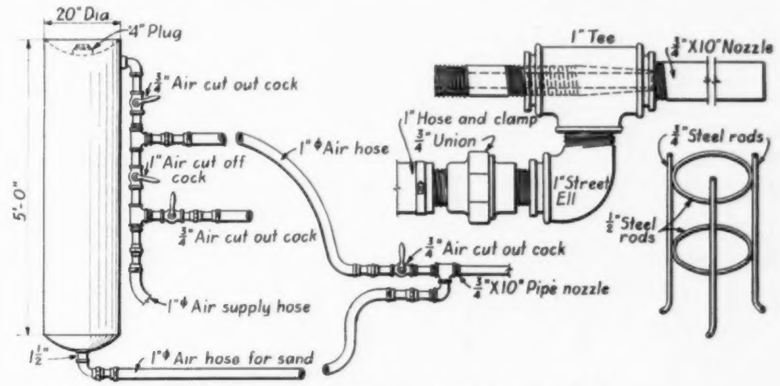
Deck girder spans	$0.47½	per ton of metal
Through girder spans	.52	per ton of metal
Riveted trusses	.70	per ton of metal

Where chipping hammers were necessary, the average costs were:

Deck girder spans	$0.82	per ton of metal
Through girder spans	.87	per ton of metal
Riveted trusses	1.15	per ton of metal

The costs of cleaning by hand or with pneumatic tools range from the figures shown above to $3 or $4 per ton. Where costs exceed about $4 per ton, sand blasting should be used, as any other method will not give a sufficiently clean surface for the proper application of paint. In sand blasting bridges it is not possible to do the work as cheaply as such work can be done under ideal conditions, because it is necessary to use portable compressors, to work from staging or scaffolding while there will be waste of sand or other abrasive.

The table on the next page gives the cost of cleaning a bridge on the Canadian National; it should be noted that the difference in cost of cleaning the various parts of the structure is due to the extent to which each part was cleaned.



Sand-Blasting Equipment Used on Southern Pacific

The bridge was 900 ft. long consisting of eight 50-ft. plate girder spans and five 100-ft. deck truss spans, with a total weight of 550 tons, and a total surface of 58,387 sq. ft. The equipment used consisted of three gasoline-driven air compressors of 160 cu. ft. capacity and three sand-blasting machines. The compressors were set up at one end of the bridge and the air carried across the full length of the deck through a three inch pipe line with branches taken off at the required intervals for connections to the sand-blasting machines.

The gang engaged in the work consisted of—

1—Foreman
1—Compressor man
1—Painter
6—Sand-blast operators
6—Laborers

None of these men had any previous experience in sand-blasting.

The time required to clean and paint this structure was 62½ working days. The amount of sand used was 158.17 tons, averaging 5.5 lb. per sq. ft. of surface. An average of 18.2 gal. of gasoline was used per ton of sand. Five of the eight deck plate girders were thoroughly cleaned, removing all old paint and rust. On the balance of the structure, only those portions showing scale and rust were cleaned, the balance of the old paint being left intact. Including labor and material, the cost of cleaning was 9.20 cents per sq. ft. or $9.77 per ton of metal.

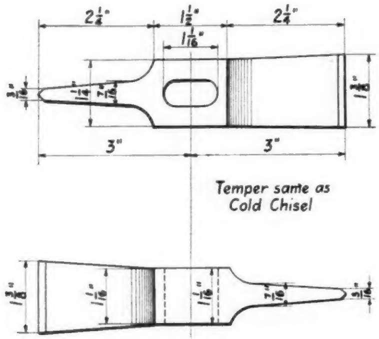
The sand-blasting of another bridge (girder span) is reported to have cost as follows:

	Per Square Foot
Labor	$ .0639
Sand	.0157
Gasoline	.0080
Oil	.0008
Scaffolding	.0098
Flag and watchmen	.0220
Nozzles	.0009
Total	$ .1206

—or about $15 per ton of metal

Figures are given also for the sand-blasting of 42,500 tons of bridge steel to remove a slight rust and mill scale, and these are considered to be the minimum for which the sand-blasting of the complete surface can be performed (the work having been done in a yard prior to erection):

Square feet of surface per ton of metal—105 to 122
Sand required for one ton of metal—700 lb.
Sand required for 100 sq. ft. of surface—570 lb.
Square feet blasted per hour with a 5/16 in. nozzle—142 (100 lb. air pressure)
Square feet blasted per hour with a ⅜ in. nozzle—130 (80 lb. air pressure)



Painters' Rust Hammer

Power cost—$0.33 per ton of steel cleaned
Abrasives—Sand—$0.96 per ton of steel cleaned
Grit—0.43 per ton of steel cleaned

The grit was recovered and reused to such an extent that one ton of grit cleaned 238 tons of steel. The total cost of this sand-blasting was $4.27 per ton of steel.

The cost of painting bridges, exclusive of cleaning, averages from $4 to $6 per ton of metal for three-coat work with a paint of good quality. One good coat can be applied for about $2, so it is obvious that a $2 coat applied in time will do the structure more good than an equal amount spent for cleaning a rusting structure.

In addition to the mechanical methods of cleaning steel that have been dealt with, some of the railroads answering the committee's questionnaire have reported the use of penetrating oils and other preparations for the loosening of rust and scale. While this method is in most cases still in the experimental stage, one railroad reported its adoption as a standard practice.

We no longer clean our steel bridges before painting. Our practice is to use as a first field coat a preparation which acts as a rust remover. Where the rust condition is aggravated and a very thick scale has formed, we spot these places a second time, which usually softens the rust and scale so that it can be easily and quickly removed with a scraper; then we apply as a final coat, a paint which contains a small amount of the ingredients of the first coat and this makes a neat appearing job and will keep rust from forming for a long time.

Where we have a bad rust condition caused by refrigerator car drippings on the flanges, gusset plates and bracing of the floor systems, we hand-clean the bad portions, apply lead paint directly to the metal and cover the leaded surfaces heavily with as asphaltic paint.

A bridge engineer of one of the large railways states that after some years use of a preparation for loosening and removing rust and scale, he has decided to discontinue any further cleaning of bridges by mechanical means, as he has found that this preparation has not only removed the rust but has also retarded further rusting to such an extent that the application of the material once every year or two continues to keep the steel in good condition.

Manufacturers of these rust removing preparations recommend that a brush or spray coating be applied that will loosen the old rust and scale, because of the fact that it penetrates entirely through to the steel, even where the surface has become badly pitted, causing much of the scale to fall off without the use of any further labor, the time required for such action depending, of course, upon the location, temperature and surrounding conditions. It is claimed that if such a preparation is made and permitted to remain until it has penetrated to the steel and the rust and scale has fallen off, another coating should be applied which will prevent further rust forming for a considerable period of time.

In undertaking the preparation of this report, the committee recognized the fact that owing to the greatly restricted appropriations for mainten-

Five Deck Plate Girders—Thoroughly Cleaned

Classification	Hours	Quantity	Cost	Cost per sq. ft.
Labor	1,429		$ 769.45	9.47 cents
Sand (tons)		33.82	186.01	2.29
Gasoline (gal.)		780	167.70	2.07
Oil (qt.)		51	15.81	0.20
Scaffolding	148		68.13	0.85
Nozzles			17.25	0.20
Erection and dismantling plant			121.37	1.49
Total	1,577		$1,345.72	16.57 cents

Five Deck Truss Spans—Partially Cleaned

Classification	Hours	Quantity	Cost	Cost per sq. ft.
Labor	3,255		$1,694.14	3.73 cents
Sand (tons)		95.5	525.25	1.16
Gasoline (gal.)		1733	372.59	0.82
Oil (qt.)		31.75	9.84	0.02
Scaffolding	391		430.23	0.95
Nozzles, etc.			48.70	0.11
Erection and dismantling plant			280.75	0.62
Total	3,646		$3.361.50	7.41 cents

Three Deck Plate Girders—Partially Cleaned

Classification	Hours	Quantity	Cost	Cost per sq. ft.
Labor	596		$ 313.57	6.43 cents
Sand (tons)		28.85	158.68	3.26
Gasoline (gal.)		365	78.48	1.61
Oil (qt.)		2.25	.70	0.02
Scaffolding	104		43.68	0.90
Nozzles, etc.			14.71	0.30
Erection and dismantling plant			55.88	1.15
Total	700		$ 665.70	13.67 cents

Total—All Spans

Classification	Hours	Quantity	Cost	Cost per sq. ft.
Labor	5,280		$2,777.16	4.76 cents
Sand (tons)		158.17	869.94	1.49
Gasoline (gal.)		2878	618.77	1.06
Oil (qt.)		85	26.35	0.04
Scaffolding	643		542.04	0.93
Nozzles, etc.			80.66	0.14
Erection and dismantling plant			458.00	0.78
Total	5,923		$5,372.92	9.20 cents
Total cost per ton of steel in the bridge				$9.77

ance work during the past few years, most railroads are faced with the problem of either undertaking a heavy bridge painting program or of resorting in the near future to a much heavier expenditure for extensive repairs or even complete renewal of many of their structures. With this in mind, every effort was made to discover some practical and economical means of preventing or retarding further damage to structures in a state of progressive deterioration.

It is the belief of the committee that serious consideration should be given to the use of oil or other preparations as a means of loosening rust and scale, before attempting expensive cleaning operations, as well as for the purpose of retarding further corrosion, and thereby extend the intervals between the times when structures require thorough cleaning and painting.

Committee—E. C. Neville, (chairman), bridge and building master, C. N., Toronto, Ont., Can.; H. Cunniff, general foreman painter, D. & H., Cohoes, N.Y.; J. J. Wishart, supervisor bridges and buildings, N.Y., N. H. & H., Boston, Mass.; W. A. Stewart, assistant supervisor bridges and buildings, Cen. Vt., New London, Conn.; W. A. Hutcheson, assistant supervisor bridges and buildings, C. & O., Clifton Forge, Va.; C. L. Metzmaker, supervisor bridges and buildings, C. & I. M., Springfield, Ill.; J. P. Yates, supervisor bridges and buildings, G. C. Lines, Kingsville, Tex.; C. N. Billings, supervisor bridges and buildings, S.P. (Tex. and La. Lines), Victoria, Tex.; A. Sweet, foreman bridges and buildings, A.T. & S.F., Newton, Kans.; G. L. Sitton, chief engineer M.W. & S., Sou., Charlotte, N.C.; E. Patenaude, bridge and building master, C.P., Sudbury, Ont., Can.; L. G. Byrd, supervisor bridges and buildings, M.P., Poplar Bluff, Mo.

Discussion

In discussing this report, President Benjamin stated that the steel for the San Francisco-Oakland Bay bridge was shipped from the bridge fabricating plant without painting of any kind and was sand blasted to a polished surface on arrival. It was found that red lead paint would not adhere to this surface satisfactorily and sand blasting was finally reduced to a less complete job, ending the difficulty.

In reply to questions, Chairman Neville reported that they originally used nozzles that lasted only 20 min., but they had finally bought harder nozzles which had proved much more economical. C. S. Heritage (K.C.S.) reported a recent conversation with a sand blasting contractor who finds the use of rubber liners in nozzles to be an economical practice.

Turning to the subject of protective coatings for steel, Chairman Neville stated that he now has a gang applying crank case oil to rusted portions to loosen scale, which method he finds much cheaper than sand blasting. C. T. Wilson, (W.M.) reported that he was using an oil on barges in Baltimore harbor in lieu of paint, with success. L. C. Smith (I.H.B.), also reported that he was experimenting with various oils as a means of overcoming corrosion resulting from excessive brine drippings.

C. M. Burpee (D. & H.), cautioned the members to be careful to insure that old paint has sufficient elasticity before applying other coatings over it, for otherwise trouble will develop in the cracking of the new coat during cold weather. E. B. Brown (M.P.) cited good results from the use of a grease on structures along the Gulf Coast. He reported that their greatest difficulty arose in getting rid of moisture which collects on metal after it is cleaned and before paint can be applied. For this condition he finds grease better than paint. No cleaning is done before applying the grease and there is very little difference in appearance.

Underwater Inspection and Examination of Railroad Structures

Report of Committee

THE old saying that "a chain is as strong as its weakest link" is particularly applicable to bridge structures. Without a foundation which can withstand the ravages of water flow, no super-structure, however strong or magnificent in appearance, can long endure. Bridge and building men have always appreciated the importance of maintaining underwater foundations with the highest degree of care, and the necessity for adequate periodic inspection of such foundations to this end.

W. R. Ganser
Chairman

Owing to unprecedented storms and rainfall in many parts of the country during the last several years, the flood damage bill on the railways has run into millions of dollars for repairs to and renewals of roadbed and structures. Large as this has been, it might have been many times larger if it had not been for the regular thorough investigation and inspection of thousands of underwater structures, which led to the strengthening or protecting of those that showed signs of weakness or of exposure to potential hazards to safety.

To ascertain the attitude and practices prevailing on the railways with regard to the inspection and examination of those parts of their structures that lie under water, the committee submitted a questionnaire to 36 roads with 221,295 miles of lines in all parts of the United States and Canada. It received answers from 30 roads. The information upon which this report is based was taken from the answers to this questionnaire.

Types of Foundations

The bridge maintenance man is particularly interested in the types of foundations that support his structures, as this determines, to a large degree, the character of his underwater inspection work and the frequency with which inspections should be made. In the majority of cases, foundations fall in one of the following classes:

Timber pile, treated or untreated
Masonry on earth
Masonry on rock
Masonry on low-water floors supported by piling
Piling surrounded with concrete masonry

Bridge foundations fail from va-

rious causes. In the majority of cases, failures have been due to flood or other unusual water conditions, and, unquestionably, many of them could not have been averted by any system or program of inspection. There are very few cases on record where foundations have failed as the result of natural scour over a long period of time for such scour is usually detected during periodic bridge inspections, and measures are taken to correct it or to offset any damaging effect that it may have. Failure to keep water courses free from tree stumps or rubbish, which block the normal course of water and divert it so that it undermines or washes away back or wingwalls, are not unusual. Frequently, such foundation failures result in the collapse of the entire structure.

It is necessary to keep water courses clear at all times, particularly pipe culverts, as they may have been designed to carry off normal railfall but not the unusual storm or flood conditions which occur perhaps once in 25 years. The stoppage of a pipe culvert will often raise the water above the pipe to such an extent that the head will either force the water beneath the pipe, or cause it to cut away the fill surrounding it and result in a washout. Masonry as well as pile foundations have failed because rivers or streams have been dredged to give a greater depth of water, causing high and fast water resulting from storms to scour away more of the bottom and cause failure.

Pile foundations generally fail as the result of natural decay or from the ravages of marine borers. The latter cause has been greatly reduced by the use of treated material, although there are cases on record where marine borers have weakened or destroyed treated piling. Stone masonry, even if on a firm foundation, may fail if the mortar or pointing is washed out, allowing the structure to stand with no bond between courses.

Slight settlement of the track over a structure and cracks in the masonry substructure are sometimes indications of weakness in or approaching danger to the bridge foundations, although not invariably. Masonry will, at times, show slight settlement and cracks due to changes in temperature, but these do not necessarily impair the strength of the structure, or indicate a weakened foundation. An alert inspector should detect all such possible indications of weakness and follow them up closely to see that they do not develop into a dangerous condition.

The responses received from practically all of the roads voice the opinion that periodic underwater inspection of structures is necessary, although a few expressed the belief that such inspection is necessary only after storm periods. The frequency of inspections regarded as necessary varied from as often as once a month to once a year, but all the reports are in agreement as to the need for special inspections immediately following severe storms. The type of inspection referred to, which has to do only with those parts of structures under water, should not be confused with regular bridge inspections, although these latter inspections very often disclose conditions in underwater structures which require immediate attention.

All of the roads questioned recognize that special conditions require special treatment as regards inspection. For example, one road cites a case where soundings are taken and recorded daily at certain bridges in seashore territory, so that any changes in the bottom, which is subject to alternate deposit and wash, can be detected immediately. The bridge and building man, knowing his territory, should program his inspections according to the character of his structures and the materials on which they rest. For example, a second masonry structure built on a rock foundation obviously should not require or receive the same attention as a similar structure, or a less sound one, built on soft soil.

Responsibility

The responsibility for the safe condition of a structure rests primarily with the division engineer and the bridge and building supervisor or master carpenter. Every railroad has rules for the periodical inspection of structures, but, because of the difficulty of making underwater inspections, special programs are frequently necessary. These special programs are, in most cases, under the direction of the system chief or bridge engineer and are carried out by division forces under system supervision.

Our investigation shows that few railroads have complete and accurate "as built" plans of all of their bridges. The majority have such plans for structures built during the last 25 years or so, but, apparently, when structures older than this were built, the necessity for such plans was not universally recognized. Undoubtedly, in many cases, plans of older structures have been mislaid or lost.

Most of the roads on which accurate records are not available have not attempted to obtain the missing information, except in individual cases where they have had cause to suspect the stability of a structure. In these cases, the information has been secured by building a cofferdam around the structure and excavating until the bottom of the foundation is exposed for examination, or by probing around the structure with sounding rods or pipes until the conditions existing about the foundation are ascertained as definitely as possible. Some roads have examined all structures for which information is incomplete, either by the methods referred to, or by digging open pits about the structures and employing divers.

Need for "As Built" Plans

Too much stress cannot be placed upon the importance of the careful preparation of "as built" plans for all structures, and the desirability of ascertaining the true condition of foundations of those structures for which such plans are not available. With such records at hand, and only with such records, can the engineer know, beyond doubt, whether he can depend upon his foundations to support his structures adequately in times of unusual conditions.

As the result of the severe flood conditions which have prevailed in many parts of the country in recent years, most of the roads affected most seriously have intensified their activity in underwater inspection, and have made a more thorough study of all bridge structures, particularly with regard to their foundations and the capacity of the waterway opening which they provide.

Common Methods

On the other hand, replies from approximately 90 per cent of the roads answering our questionnaire disclose no important departures from older methods of making inspections. The most common methods of inspection include sounding with a weighted line, or with a rod or pipe, the use of a licensed diver and the construction of cofferdams to permit the dry inspection of foundations.

Soundings are used universally, primarily to determine the relative levels of the bottom of a stream or body of water and the bridge foundation, and may be made with various types of equipment. One of the most dependable sounding lines is a chain marked off at five-foot intervals with leather thongs. Such a line is not subject to elongation and shrinkage, and discloses the depth of water at a glance. The weight on the end of the line must, of course, vary with the conditions under which the soundings are taken. Care must be taken in the use of ordinary hemp rope or sash cord for sounding lines, as it

changes length quickly and will give false indications, unless checked continually for accurate length.

Soundings taken with pipes or rods give indications that cannot be secured with a line. A pipe with an elbow at the bottom, fitted with a short piece at right angles to the main rod, will permit sounding or probing along the bottom of a masonry structure.

A very satisfactory sounding rod is made of half-inch pipe, cut in short sections which can be fitted together, and equipped at the lower end with either a point or a right-angle piece for probing, or with a spoon for bringing samples of the bottom to the surface.

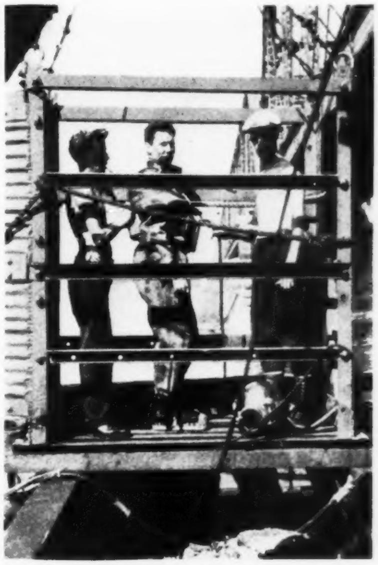
While general inspections are made quite frequently on most roads, approximately 70 per cent of the roads reporting indicate that they observe no arbitrary program for making periodic soundings, but require the division forces to determine what work of this nature is necessary. The other 30 per cent of the reporting roads make soundings twice a year, and, in addition, immediately following severe storms.

The range or extent of the sounding done varies widely on different roads, but the general consensus is that accurate measurements should be made both up and down stream for at least 200 ft., or further as conditions may require, as well as on the line of the bridge. It has long since been learned that the condition of the stream both ways from a crossing has a definite effect upon the action of the water directly about a structure. With the necessary knowledge of bottom conditions immediately each way from a structure, one is forewarned of possible damaging influences, that may not come into full play until flood stage, and can take the necessary action to guard against them.

Divers are employed on occasions by about 70 per cent of the roads to secure information at places where soundings or probings are not feasible, or where some concern exists as to the condition of foundations, and the true condition cannot be determined readily in any other manner. A few roads have on their payrolls, licensed divers, or men licensed to do diving work and employ them to make periodic examination of all structures in deep water.

Inspection by a diver requires the employment of sufficient men and equipment to safeguard the man who is making the inspection, as well as to facilitate the operation so as to keep the expense of the work at a minimum. Under even the most favorable conditions, however, regulation diver operation is costly. The diver must be equipped with regulation equipment, including suit and helmet, weighted shoes and belt, air pump and a hose. In some cases, to facilitate his work, it is necessary to employ derricks, scows, floats, sheet piling and shields of various types and shapes.

A two-way telephone between the diver and the surface is used by some roads to make it possible for the diver to transmit his findings currently to the phone man above the surface, who promptly records the data. This equipment obviates the necessity for frequent trips to the surface to report conditions observed, thereby saving time and expense, and also insuring more accurate notes. Special protection is necessary in many cases, especially in deep, fast-running water, to prevent the diver from being swept away, or into protruding spikes or timbers, as well as to avoid the fouling of his air and safety lines. Failure to provide suitable protection for a diver reduces the accuracy of his inspection of the structure, and may result in a serious accident.



Diver and Helpers in Protection Cage

Uses Swimmer

One road reports the employment of an expert swimmer, who is able to examine structures in water up to 20 ft. in depth without the aid of a diving suit. Experience with this practice is said to be highly satisfactory, it being stated that the inspections made by the diver have proved very accurate, and that they have been carried out at relatively small expense.

The Canadian National has employed the services of divers extensively, especially on its Central region. The following is an outline of the practices followed on that road:

A diving crew was organized, consisting of a foreman, diver, diver's tender, two pump operators and an experienced draftsman. Standard regulation diving apparatus was provided. This consisted of helmet and suit, weighted belt and shoes, life line and air line, together with a three-cylinder pump. A two-way telephone instrument fitted to the inside of the helmet provided the communication between the diver and those in attendance above the water. The draftsman made notes from the diver's reports and later made sketches from the reports of any conditions that differed from those recorded on "as built" plans. Scouring around or under the structure or any erosion of the masonry or movement or settlement of the stones in the piers by reason of ice jams, were noted.

While the foreman of the crew had had experience in masonry construction and the diver was an experienced man, the rest of the crew, consisting mainly of junior employes in the engineering department, had had no previous experience. They soon became proficient and proved adept in building and placing current deflectors to protect the diver in swift running water as well as rigging derricks and driving steel sheet piling around the deflectors.

The current deflectors consisted of timber A-frames floated out ahead of the nose of the pier and anchored. They served as a frame around which sheet piling was placed forming the protection for the diver.

In almost all cases the work was carried on from a rift or float composed of 12 empty oil drums lashed together in 3 sections of 4 drums each, the whole being floored over with 2-in. planking making a deck about 15 ft. square, upon which the air pump was placed and operated. Ladders used by the diver in getting to and from the bottom of the river were made of 2-in. wrought iron pipe rails and 1-in. pipe rungs welded together. They were in lengths of 16 ft. and 20 ft. and could be coupled together when the depth of the water required a longer ladder.

The most satisfactory way of inspecting piling in tidewater territory is to pull some of the piles in question and then cut them into sections so that definite knowledge can be had as to the extent that they have been attacked by marine borers. Inside decay in piling can be detected by striking the side of the piling with a hammer or other heavy instrument. If decay exists to any appreciable extent, the piling will give out a drum sound. If any sign of decay is detected, further investigation should be made by boring into the piling with brace and bit, or with an increment borer, which will show the thickness of the shell that is still supporting the structure. Piling generally shows first signs of decay at a point approximately 4 ft. above the low waterline, and should be carefully watched and inspected at this point.

Cofferdams, because of the expense

which they involve, have not been used to any extent in inspection work, except in rare cases where very fast water is encountered or where the engineer is almost certain that repairs will have to be made upon the completion of the investigation. Test borings likewise have been little used in routine inspection work, but they have been employed extensively in determining the character of soil preliminary to the construction of new facilities.

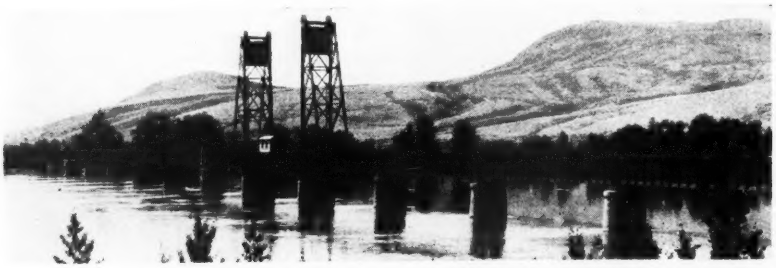
One of the most important phases of any inspection work is the establishment of a satisfactory method of compiling and recording the information secured. This is important not alone because it provides a permanent, accurate record, but also because it permits subsequent data to be compared most conveniently and effectively, with those obtained earlier. There is considerable variance in the manner in which the different roads record inspection data. Some use permanent note books, while others use a card index system or special inspection form on tracing cloth and blueprint paper. One road paints sounding data directly on its masonry structures so that anyone making either a routine or an emergency inspection, can see, as he takes measurements, whether any change has occurred without the necessity of referring to office records.

No class of maintenance work is more important, or should be given more careful consideration, than the underwater inspection of railroad structures. The slightest neglect or carelessness in this work may be the cause of placing a most important line out of service, or, of greater importance, be the cause of a serious disaster.

Committee—W. R. Ganser, (chairman), master carpenter, P.R.R. and P.R.S.L., Camden, N.J.; E. C. Neville, bridge and building master, C.N., Toronto, Can.; A. B. Scowden, general bridge inspector, B. & O., Cincinnati, O.; H. A. Gerst, assistant bridge engineer, G.N., Seattle, Wash.; J. S. Lowe, supervisor bridges and buildings, N.Y. N.H. & H., Boston, Mass.; C. A. J. Richards, master carpenter, P.R.R., Chicago, Ill.; J. F. Lockwood, supervisor bridge erection, C. & O., Richmond, Va.; John E. Bird, assistant supervisor bridges and buildings, N.Y.C., Corning, N.Y.; J. V. Inabinet, master carpenter, S.A.L., Tampa, Fla.; N. D. Howard, eastern editor, *Railway Engineering and Maintenance*, New York City, N.Y.; E. R. Tattershall, supervisor of structures, N.Y.C., New York City, N.Y. Wm. C. Harman, supervisor B. & B., S.P., San Francisco, Calif.; H. C. Jones, bridge inspector, S.P., Portland, Ore.

Discussion

E. C. Neville (C.N.R.) stressed the importance of knowing the character of and changes occurring in a stream for a considerable distance, both below and above the structures crossing them. He said that it had been his experience, in common with other bridge men, that the construction of other structures, even as far away as one-half mile above the existing structure, may create serious changes in the bed of the stream and the direction of the current. This danger is greatly increased when the new structure lies within a short distance above the existing structure.



Structures Such as This Should Have Periodic Inspection

He also described the method of providing two-way telephone service between the diver and the float from which the diver works, and said that experience had shown that it saves more than half of the diver's time. A particular advantage of the two-way telephone conversation is that the contact man on the float can make notes of what the diver finds as he finds them and that after the diver comes up to the surface, he can confer with him to make a check and ascertain whether the notes are correct and complete. He said that some of the jobs investigated on the Canadian National were in water having a depth of 30 to 40 ft. and in currents ranging from 8 to 12 miles per hour. Where strong currents were encountered, A-frames were lowered to project several feet outside of the line of the pier or abutment. After the A-frame was landed, it was used as a guide for driving sheet piling. In deep water with swift current, it was very difficult to handle the sheet piling and be assured that it would be driven in proper position but this was the only way the diver could be protected. This diver inspection was carried on for about four years on the central region of the Canadian National until all structures had been given under water examination.

W. C. Harman (S.P.) said that in his territory the inspection of treated piles both above the ground and for about four feet below is important to insure against overlooking termite infestation. It has been the experience of his road that where green timber is treated by the full-cell process and driven in structures in the arid sections, the piling cracks and opens up below the zone of treatment, giving an opportunity for the entrance of termites and that in this territory, particularly, piling must be given special inspection to insure freedom from termite action.

He said also that in the flood that occurred about three years ago in the Tehachapi canyon all bridge foundations which rested on bed rock withstood the impact of the flood, although in some cases the bridges themselves were covered with debris washed down by the flood waters. All other structures which rested on boulders or other material but not on bed rock were washed out. As a result of the experience during this flood, all foundations on the Pacific System have been examined. On some of the high viaducts on the Coast lines it was necessary to construct coffer dams to reach below the footings.

John L. Vogel (D.L.&W.) stated that after the flood in central and southern New York last summer, all foundations in this territory were examined, it being necessary in a number of instances to employ divers for this purpose. The older structures on this line were completed between 1882 and 1884 and practically all of them rest on hemlock grillages on either gravel or stiff clay foundations.

During the period of the flood one pier, which had been surrounded by earth to a height well above normal high water, was undercut and the location of the pier scoured to a depth of 17 ft. below the footing while two spans away scour occurred in front of another pier to a depth of 12 ft., although the pier itself was not destroyed. In all cases where scour occurred during this flood and the pier was not destroyed, the condition was corrected by surrounding the footings with steel sheet piling and excavating to a depth considerably below the original footing, after which the piling was surrounded by a curtain of con-

crete placed by means of tremies. In a number of instances, grout was then forced into the stone masonry footings by means of high-pressure pumps.

President Benjamin called attention to the special importance of watching highway construction to see that bridges and culverts are not so placed as to endanger existing railway structures. W. A. Batey (U.P.) emphasized what President Benjamin had said and stated that shortly after the construction of U. S. Highway 40 in Nebraska, 60 Union Pacific bridges and culverts were washed out as a result of this new construction and that some of these structures had been standing since 1869 without having given previous trouble. He also emphasized the desirability of painting inspection data on the piers and abutments of bridges, including the penetration of piling in the foundation. With this data section foremen, roadmasters and bridge inspectors can quickly determine any change in conditions at the time they make the inspection, whereas if this information is not available on the ground it is necessary to go to headquarters to determine whether conditions have changed. He said that these inspections are made after every severe storm.

Mr. Neville then called attention to the fact that most maintenance officers are concerned about the safety of structures over streams in which floods occur frequently. On the Canadian National, however, it has been found that some of the worst conditions existed in structures over streams that are subject to very little fluctuation in height and that the trouble is caused by obstructions in the stream deflecting the current or by new structures which have been built above the railway bridges.

F. B. Murray (C.N.R.) said that while there are no plans available for any of the older structures, the situation with respect to later structures is often almost as bad, for the reason that the plans are drawn before the bridge is constructed and that the construction engineer often fails to add the data concerning character of soil, added or decreased depth of footings, penetration of piling and other information that will be of value in determining the condition of the structure when the examination is made.

Relative Merits of Different Types of Pumps

Conditions Under Which Each Is Most Suitable

Report of Committee

THE source of a water supply is an important factor in the selection of pumping equipment. Where the supply is secured from a reservoir or lake and the stage of water is subject to slight variation, the problem is comparatively simple. In many cases, however, particularly on many of our southern rivers, there is a wide variation in the stage of water, sometimes amounting to 60 ft. or more. This is also true of deep wells where the pumping head may be 400 ft. or more below the surface. While different types of pumps may be used under these conditions, some one particular type will usually be found most satisfactory. Pumps commonly used in railway service may be grouped under four general heads:—reciprocating pumps, centrifugal pumps, air lifts and rotary pumps.

C. R. Knowles
Chairman

Reciprocating pumps represent the earliest type and are used more extensively than any others. While the centrifugal pump is a more recent development it is rapidly replacing the reciprocating pump for new installations. The air lift is used under certain conditions for pumping from deep wells. While the air lift is less efficient than any other type of pumping equipment there are conditions where its advantages offset the lower efficiency, as for example, in very deep wells with an extremely high lift, in wells that were not drilled perfectly straight and for water containing considerable grit or sand. A lift of 400 ft. is not at all uncommon in certain parts of the West, and in individual cases these lifts are as high as 900 ft. Under these conditions the overall efficiency and economy of the air lift compares favorably with other pumping equipment; in fact, there is a question whether either a turbine or reciprocating pump could be operated successfully with pumping heads of 800 or 900 ft. below the surface. The rotary pump has not been used extensively in railroad service, although it is coming into use in the smaller sizes for pumping chemicals used in wayside treatment.

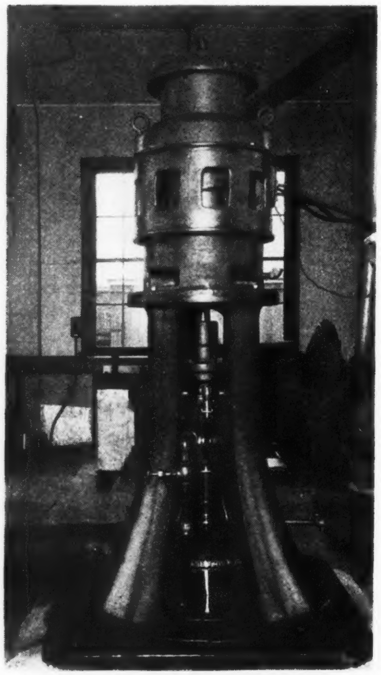
The changes in the power units used to drive pumps have been quite as revolutionary as the changes in the design of the pumps themselves. At the beginning of the century pumps at railway water stations were driven almost exclusively by steam. For a time, gasoline engines were installed in place of many steam plants, but they were subsequently superseded by the semi-diesel oil engine, which is still used extensively at railway water stations. The wide extension of power lines and reductions in the cost of electric current have made it possible to install many electric-driven pumps, replacing both steam and oil to a large extent.

The Illinois Central, for example, has within the last 20 years remodeled and enlarged 129 steam operated water stations, installed oil engines at 55 stations and replaced steam with electric power at 30 others, in addition to installing combinations of two or more of these sources of power in 17 plants. Practically all of the new pumps installed during this period have been of the centrifugal type, the existing steam pumps in many instances being transferred to remodeled and enlarged steam plants.

Steam

The steam pump has been used longer than any other type of pump now in use. Steam pumps, as a rule, are simpler in operation and more flexible than any other type of pump,

as the speed or rate of pumping may be regulated readily by the throttle valve, while with other types of prime movers, variations in speed must be accomplished through a rather complicated system of reducing gears, or by different sizes of pulleys in a belt drive. The principal disadvantage of the steam plant is the necessity for constant attendance. While the fuel cost is much less than that of a gasoline engine, and as a rule is lower than the cost of electric current, it is higher than the cost of the fuel for either a semi-diesel or a diesel oil engine.



Pump Head for Deep-Well Pump

The cost of maintaining a steam pump and boiler is greater than that of an electric motor, and as a rule is in excess of the cost of maintaining an oil-driven pumping unit, depending upon the character of the feed water used and other conditions. Many of the steam-operated railway pumping stations now in service were installed before the development of oil or electric pumping units, and in all probability the majority of them will be replaced by oil or electricity as they wear out or become inadequate for the demand. In a number of cases, however, where steam is required for purposes other than pumping, the use of steam pumps will be continued indefinitely.

Internal Combustion Engine

The term "internal combustion engine" includes gasoline engines, diesel engines and engines of the so-called semi-diesel type. The gasoline engines used in railway water service are rapidly being replaced by other equipment, except for small installations and for portable pumps, because of the high cost of fuel with such operation.

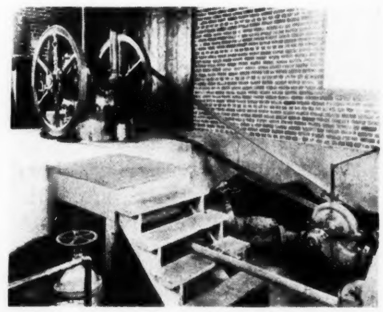
The true diesel engine differs from the so-called semi-diesel type of engine in that it operates under higher compression, and ignition takes place from the heat generated by compression. This initial ignition in the true diesel engine is accomplished through the use of auxiliary air-compressor equipment. With the so-called semi-diesel, or low compression, type of engine, the oil is injected in liquid form and the ignition is accomplished by the use of a tube or hot ball which is preheated by a torch.

The true diesel type engine is not generally adapted to use at railway water stations because engines in types suitable for use at water stations have not been constructed in sizes under 40 hp., while the requirements in railway water stations seldom exceed 30 hp. Developments in the diesel engine, as used on tractors, cranes and similar equipment within the past few years, indicate that engines of the true diesel type will probably be available in the near future in sizes adapted to railway water stations.

The advantage of the true diesel over the semi-diesel type is its greater fuel economy, as it has been found in actual practice that the true diesel uses approximately 0.5 lb. of fuel per horsepower-hour as compared with an average of 0.8 lb. for the so-called semi-diesel type. The initial cost of the diesel engines, of course, is more than that of the semi-diesel type, and the cost for maintenance is approximately the same. Both the diesel or semi-diesel types are well adapted to the operation of power pumps of all types by means of various drives.

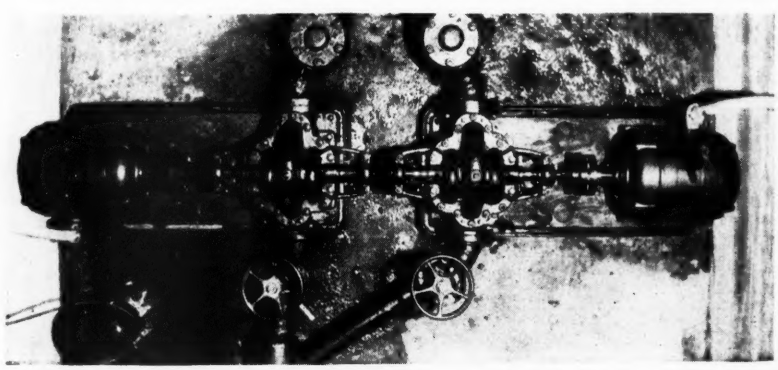
The power cost for diesel engines, independent of other operation or maintenance charges, is lower than that for any other driving unit. With a fuel cost of $0.05 per gallon, the power cost is equivalent to a rate of approximately $0.01 per kw.h. for electricity and a cost of about $1 per ton for coal for the ordinary steam pumping station.

The operation of pumps by electricity offers many conveniences and advantages over other forms of power where suitable rates for electricity may be obtained. The electric motor is well adapted to driving power pumps, particularly centrifugal pumps, as it may, in most instances, be connected direct to the centrifugal pump with the use of a minimum of floor space for the pump and motor. With power pumps of the reciprocating type it is necessary, of course, to use reducing gears because of the relatively high speed at which the motor must operate.



Oil Engine Driving Centrifugal Pump

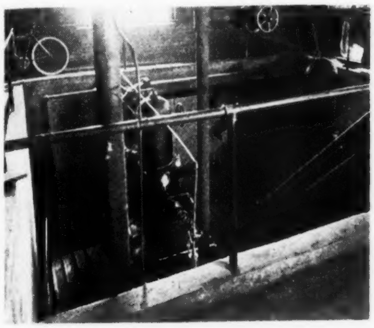
The electric motor may be operated with little if any attendance other than an occasional inspection and oiling. The maintenance costs are also much lower than for either the oil engine or the steam pump and boiler. The control may be manual, push-button or automatic. Where push-button or automatic control is used, either alone or in combination, such control may be entirely remote from the pumping unit itself, and if desired may be located several miles away. The adaptability and economy of electric power will depend upon



Duplicate Installation of Electrically Driven Centrifugal Pumps

the availability of power lines, and the demand or readiness-to-serve charge and the power rates.

The relative efficiency of the different types of pumping equipment is of chief importance when comparing pumps of the same type, as, for example, one centrifugal pump with another. This is because the selection of any particular type of pump will, as a rule, depend upon local conditions rather than upon the efficiency of the various types. For example, at terminals where electricity is available the demand charge is usually negligible, and the rate for current relatively low, while if steam is readily available steam operation will probably prove more economical. In



A Steam Pump in Pit

the absence of either steam or electricity at isolated points internal combustion engines are probably more desirable.

It is a characteristic of the centrifugal pump that the impeller must be designed for the particular condition under which the pump must operate, and any material variation in head naturally affects the efficiency of the pump. For example, with some impeller designs the horsepower required when operating against heads lower than that for which the pump was designed may increase to such an extent that the motor or other power unit will become overloaded, while the operating head on other types of pumps may be reduced to a minimum without overloading the motor. It would, of course, be possible to install a motor of sufficient size with any type of pump to guard against overloading. This, however, would materially affect the overall efficiency of the pumping unit and result in an excessive demand charge for current.

Reciprocating pumps of either the steam or power type are not affected by any variation in head, for, being of a displacement type, the discharge of these pumps varies directly with the speed.

The requirements for different types of deep-well pumps may be made more specific. For example. displacement or reciprocating pumps are adapted to pumpages of from 50 to 300 gal. per min., and to varying depths of pump setting of 300 ft. or less. The drive may be either steam, electricity or internal combustion engine. The steam drive usually consists of a vertical cylinder with a stroke of from 24 to 36 in. With the use of either electricity or the oil engine, the drive may be either by belt or through a reduction gear.

The vertical turbine pump is adapted to pumpages of from 50 to 6,000 gal. per min., and to various depths of setting to a maximum of 500 ft. In the case of pumps with a submerged motor the depth of setting is limited only by the depth of the well.

The air lift has a wide range of use in pumping from wells and is particularly adapted to use in wells where a very deep pump setting would be required, as for example, 500 ft. or more. As stated previously, it is also more suitable than other types of pumps for installation in crooked wells or wells that produce considerable sand. Practically the only limitation of the air lift is that it must have sufficient submergence under all pumping conditions. As a rule the submergence should not be less than 35 per cent of the total lift.

The most satisfactory type of pump installation to be used in a given case can best be determined by a careful study of local conditions and estimates of the power cost, the cost of operation and maintenance, and the interest and depreciation on the total investment.

Committee—C. R. Knowles (chairman), superintendent water service, I.C., Chicago; W. S. Lacher, managing editor, *Railway Engineering and Maintenance*, Chicago; J. H. Bugg, supervisor water service, C.N.R., London, Ont., Can.; T. B. Turnbull, superintendent bridges and buildings, A.A., Owosso, Mich.; L. C. Smith, supervisor bridges and buildings, I.H.B., Hammond, Ind.; J. P. Wood, supervisor bridges and buildings, P.M, Grand Ledge, Mich.; W. L. Wallace, supervisor water service, P. M.. Saginaw, Mich.

Discussion

Referring to that portion of the report dealing with the use of Diesel engines for the operation of pumps. A. Chinn (Alton) raised the question as to whether the widespread use of such engines would cause an ultimate increase in the price of fuel oil, thus offsetting the economies of these pumps. Mr. Knowles replied by citing the experience with distillate, which formerly was a drug on the market because of the lack of demand for it. Since the creation of a market for this product in the operation of certain types of engines, Mr. Knowles pointed out that, while the price has increased appreciably, the increase has not been sufficient to offset the economies accruing through the use of this fuel. Mr. Knowles also pointed to the fact that despite the increased consumption of fuel oil during the last few years in home use and elsewhere, the price has not increased but on the other hand has shown a slight decrease. It is Mr. Knowles' opinion that it will be many years before the price of fuel oil begins to approach that of gasoline.

A. L. McCloy (P.M.) pointed to that portion of the report which recommended that the submergence of an air lift pump should not be less than 35 per cent of the total lift and said that it was his experience that the submergence should be about two-thirds of the lift. Mr. Knowles agreed with the latter figure and called attention to the fact that 35 per cent submergence recommended in the report is the minimum. Mr. McCloy described an air lift installation in which the lift was operated by exhaust gases from a six-horse-power gasoline engine.

T. B. Turnbull (Ann Arbor) described the water service facilities on his road, saying that water was obtained from city water departments and springs, and that at other locations hydraulic rams, steam plants, semi-Diesel engines and electric pumps were employed in pumping water. He asked if the centrifugal pump was as efficient as the reciprocating type. Mr. Knowles replied that the centrifugal pump is generally rated as being slightly more than 70 per cent efficient, while reciprocating pumps are considered to be from 85 to 90 per cent efficient. However, because of the condition of the packing and valves in reciprocating pumps, he doubted if the disparity between the efficiencies of these pumps was a great as indicated by these figures.

W. L. Nies (Fairbanks, Morse & Co.) explained that the displacement pump is best adapted to conditions requiring the pumping of a small volume of water against a high head, while the centrifugal pump is most efficient when pumping a large quantity of water against a low head. In discussing the cost of fuel oil. Mr. Nies said that, while it is conceivable that the cost of this oil will increase with greater demand, it is not likely that it will ever approach that of gasoline because only one-half as much fuel is required to produce a horsepower hour. He described a type of installation where

10-hp. Diesel engines, operating at 1,200 r.p.m., are used to operate electric generators in lighthouse service on the Great Lakes. The installations, he said, are made in duplicate in order to guard against interruptions in service through the failure of one of the engines to start. The engines, he said, are controlled automatically by means of photo-electric cells that are sensitive to changes in light conditions.

Mr. Chinn asked what had been done to prevent the accumulation of dirt in the injectors of Diesel engines. Mr. Nies pointed out that the injector orifice in Diesel engines is only about 0.015 in. in diameter and, therefore, it is difficult to keep them from becoming clogged with dirt. He said, however, that an effective oil filter had been developed, which consists of a large number of brass discs, which may be cleaned by turning a handle. Mr. Nies described a pump installation on the Grand Trunk Western, in which the pump is equipped with a propeller similar to a ship's propeller. In this installation, he said, the pump is connected directly to a crane, there being no storage tank. Mr. McCloy pointed out that such installations are well adapted to a climate where there is much cold weather as they are more or less "foolproof" and there is not much danger of delays occurring in the water supply because of the freezing of the equipment. Mr. McCloy said that there are two types of centrifugal pumps in service on his road, one type having small impellers operating at 3,600 r.p.m. and the other having large impellers operating at 1,800 r.p.m., and wondered which of these types was the most efficient. Mr. Nies replied that the efficiencies of such units depend to a large extent on the head against which they are pumping. In making a reply to a question from Mr. McCloy, Mr. Knowles said that in general single-stage pumps are more efficient than multiple-stage units. In this connection Mr. Nies pointed out that the initial cost of the single-stage pump is less than for the multiple-stage type and that it is more economical to maintain than the latter type of pump.

The Welding of Pipes for Water Supply, Plumbing, Etc.

Report of Committee

THE instructions to your committee were quite general and not restricted to particular phases, so that during our survey a wealth of material was assembled. It was, therefore, our duty to select and present certain of the general items rather than attempt detailed descriptions which, while interesting and valuable, would extend this report to such length as to prove objectionable. We present, therefore, brief descriptions of past and present uses, methods of installation and resultant advantages of the use of welded pipe lines for carrying water, steam, oils, liquids and gases.

C. Miles Burpee
Chairman

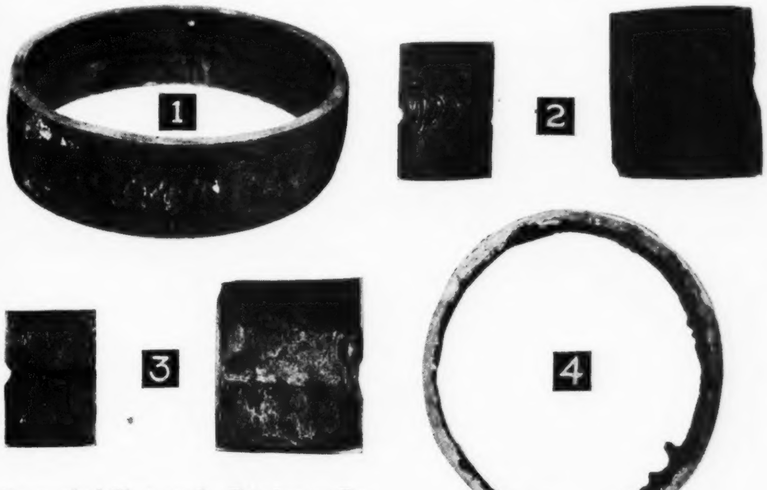
Past Performances

One mid-western road first welded pipe in 1913 and has recognized this method of installation as standard practice in all power and general service work since 1920. An eastern railway installed a welded steam line, all welding being done by a contractor, about 15 or 16 years ago. The pipe was assembled with standard threads and couplings and later each end of the couplings was welded, while standard flanged branches and fittings were used. The initial assembly was thoroughly done and in all probability the line would have been steam tight without the welds. However, it is subject to very severe service conditions, it is supported on posts, the bottom of the line is about one foot above the ground and it is covered on the sides and top with a wooden box for protection, the top of which is used as a walk-way by men in the yard. It is adjacent to a side-track used for icing cars, the boxing and supporting posts have deteriorated owing to deferred maintenance, and the pipe is considerably out of surface and line, but in spite of all unfavorable conditions, no leaks have developed, and in all probability the line will be serviceable for several years to come.

During March, 1928, the same railway placed in service a new engine house wherein all pipe lines and branches were welded and the use of fittings eliminated to a considerable extent. The oxy-acetylene process was used to make welds in place as it was impossible to roll the pipe, since the line conforms to the radius of the building. It was not curved but changes of direction were made at the welds at each roof truss. The end of one pipe was flanged slightly while the adjoining end was beveled to form a socket fit prior to welding. Cuts made at several joints disclosed imperfections, indicating the possibility of imperfections even in lines where the larger proportion of the welds may be perfect. This job was also done by a contractor under railway inspection. The line developed a great many pit holes in service and the interior became encrusted with ferro-oxide deposits. The water is obtained from a local supply containing a large proportion of vegetable matter which, when heated, attacks the iron pipe very quickly. A portion of the line is 5 in. in diameter, while the remainder is 6 in., and the latter section which has been used much more than the 5-in. line, was found to be so encrusted that its capacity was cut down more than 50 per cent. The pipe is now being replaced by a cement-lined pipe with flanged fittings.

During 1929 the same eastern railway installed an 8-in. welded steam line placed in a cast iron conduit transversely under 23 yard tracks, with a riser at each track for car-heating service. Many leaks developed during the first year's service and by the end of the fourth year maintenance costs had increased to such an extent that the line was condemned. The welding in this instance was all

of the place type and done by a contractor. Examination during abandonment operations showed porous, uneven, poorly fused welds and that a large amount of metal had been allowed to run down inside the pipe.



Unretouched Photographs Showing an Example of Poor Workmanship in an Oxy-acetylene Place-Weld in a Six-Inch Wrought Iron Pipe. Fig. 1 Shows a Large Pit Hole to the Right of the Center Line, Fig. 2—Enlarged Exterior Views of Two Pieces Cut from the Weld, Fig. 3—Interior Views of the Same Pieces, Fig. 4—Shows How Weld Metal Formed Globules on the Interior of the Pipe.

It was quite apparent that railway inspectors were not properly qualified, since most of the leaks were found on the bottom of the line in a difficult position for the welders to reach.

Replacement

Replacement was made by an overhead line carried on steel supports over 14 tracks, and encased in an improved conduit underground for the remainder of the distance. Rolled welding was used in this instance and the pipe set in a cold strain. The entire line is without expansion joints. In this instance a more reliable and experienced contractor was employed. A detailed inspection was made of every weld, using 200 lb. hydrostatic pressure, while the pipe was subjected to severe hammer blows at each welded joint in an attempt to loosen any imperfectly fused metal. Three men made separate individual inspections and checked with each other at each joint. The welding was done by the oxy-acetylene process, and the line has been in service for one heating season without developing any leakage whatever.

Comparatively few railways are using welded pipe line installations for either new or maintenance work, although a comparatively large amount of piping is installed and maintained in this manner, with estimated savings of from 20 to 50 per cent over old methods in total installation costs. Replies received from 11 railways indicate that welding is being used in ordinary maintenance, while 3 of the replies were in the negative.

Both oxy-acetylene and electric welding are used, the choice depending entirely upon local conditions, the purpose and locations of the various pipe lines. A marked divergence of opinion has been expressed as to which form is more efficient. With work properly carried on under proficient supervision, equally satisfactory results may be attained with either process. However, it is quite apparent that for general maintenance of way work the oxy-acetylene system is preferred by a large majority because the equipment is simpler, requires less capital expenditure, is more readily transported from place to place and the supplies of oxy-acetylene are generally available over entire railway systems.

All Sizes Being Welded

Practically all sizes of wrought iron and steel pipe are being welded successfully and economically, while several cases are on record of the welding of brass pipe with equal advantage. Welded lines are used for the transmission of water, steam, air, oils and gases with reported pressures varying from 65 to 150 lb. per sq. in. Some railways are using welding to advantage on small jobs, as in small houses or stations, while others are doubtful of its effectiveness or do not use the process in these instances.

The organizations for welding vary considerably, depending upon the location, type of work and the territory under the direct supervision of the person responsible for the maintenance of pipe lines on divisions, districts or systems. However, it is quite evident that regular journeymen have become proficient in the art of welding and the designing of pipe fittings, either through the benefit of educational classes organized by the railways, or through vocational classes developed in conjunction with the public school system.

Plans

It is apparent that satisfactory and efficient welded pipe lines may be installed by either contractors or railroad company forces. In the former it is quite necessary that dependable and experienced contractors be selected, that the railways' inspectors should be thoroughly experienced welders qualified to perform the work themselves, and that the work conform to definite inspection rules and regulations, the object of which is to secure proper materials and workmanship in conformity with plans and specifications. However, it is the feeling of the committee that in the interest of economy, efficiency and service, pipe line welding should be conducted by properly educated and instructed journeymen under the supervision of the officers directly responsible for construction and maintenance work.

A great deal of information and many opinions concerning the advantages of welded pipe lines were received. These data are described under the following headings: (1) Plans, (2) installation, (3) joints, (4) pipe, (5) efficiency and (6) practices.

Plans—It is apparent that where welding is substituted for conventional threaded joints, drafting room practices may be simplified. Dimensions in some cases may be given merely between center lines of fittings and straight lines may be used to indicate the pipes. Fittings welded in the field give a greater latitude in installation, as exact degrees for directional change do not necessarily have to be adhered to, while the elimination of flanges further simplifies drafting. No additional clearance is required for the location of joints between pipe sections, since the outside diameter of the welded joint is essentially no more than the diameter of the pipe. This form of installation will also result in a much smaller material list.

Installation—Changes of direction due to unforeseen obstructions are made more readily and economically during installation with welded than

with threaded pipe. Greater economy in installation may be obtained because welding involves less handling of machinery and obviates the handling of pipe to and from the threading machines. Welding outfits are transported to and along pipe lines more readily and economically than are threading machines, especially during the installation of pipe of large sizes. A smaller organization is also able to handle welded lines.

Replies to the questionnaire indicate that a welded job may be installed in less time than the conventional threaded line, with a resulting saving in labor and a reduction of 10 to 50 per cent in erection schedules. A few replies indicated that there is no saving in time in the use of welding for pipes under 2 in. in diameter. Another decided advantage in installation is the fact that several welders may work on the same line at one time, since it is unnecessary to wait for successive lengths of pipe to be applied.

Joints—During 1932, the General Electric Company conducted a series of tests designed to secure accurate data on the characteristics of arc-welded pipe joints. The detailed description of the series of tests is recommended for the consideration of those particularly interested in this phase of the subject. The conclusions indicate an average tensile strength of 60,000 lb. per sq. in., an average ductility of free-bend test of 45 per cent, while freedom from slag inclusions and porosity come well within the A.S.M.E. Boiler Code requirements for Class II pressure vessels. This report also refers to the fact that 11,881 miles of transmission pipe in the oil fields had been welded up to May 1, 1932, and a survey made by the American Gas Association during the early part of that year indicated that 50 per cent of the welded pipe lines in existence at that time were arc-welded.

One manufacturer devised a test called "The torture rack," designed to produce stress reversals at the elbow while under pressure. In a test conducted with a pressure of 100 lb. per sq. in., the screwed joint, although carefully prepared and inspected before assembly, developed a leak after 26 oscillations while the welded joint withstood 200,000 oscillations with no sign of failure.

Pipe—Ordinarily, beveled pipe may be procured for welding at a considerable saving over that with threads and couplings. No scrap pipe or expensive fittings are left over. Stock lengths of pipe, which are obtainable at lower cost, may be used, since it is unnecessary to order standard lengths as with threaded pipe.

In a great number of instances pipe with less wall thickness, approximately 25 per cent in the smaller sizes and 40 per cent in larger sizes, may be used where welding is intended, since extra thickness is not required to compensate for metal removed in thread cutting. In fittings, the weight advantage is even more marked, and differences up to 75 per cent have been noted in favor of the welded fitting.

Considerable flexibility will be found in a line of welded pipe as it bends easily through a long radius; and it may be made to conform readily to the contours of the ground. It may be bent to a rather short radius, when necessary, without injury to the welds. Flexibility of installation is also attained by the use with which angle bends of any number and dimension may be manufactured on the ground.

Expansion and contraction are provided for in a welded pipe installation in the same manner as in a threaded system, similar loops and joints being used. These may be made to practically any desired shape, fabricated on the job from standard welding fittings and straight lengths of pipe. Such alinement. The cost of insulating material for welded lines may run as much as 5 per cent less than for threaded piping.

Efficiency—A smoother inside surface, free from projecting pipe ends, and the replacement of abruptly-bent threaded fittings by sweeping turns results in substantially less friction and turbulence in welded pipes. Increased efficiency in heating systems also results from the use of thin walled pipes. In water supply lines for domestic or municipal use welded pipe will deliver cleaner water at once, since no oil or joint compound is required as in threaded lines.

Railroad pipe lines present the maximum of vibration, water hammer, contraction and expansion. Railroad service, in general, is perhaps one of the severest tests which may be imposed upon welded pipe. The result of the test conducted by the manufacturer referred to indicates what may be expected from a service standpoint as between properly assembled pipe lines with threaded fittings and those connected by welding.

Radiation loss will usually be less for welded pipe than for threaded and flanged systems, since the outer

Fig. 5—Pitting and Corrosion On a Weld in a Five-Inch Wrought Iron Hot-Water Line After Seven Years' Service. Fig. 6 and Fig. 7—Examples of Good Oxy-acetylene Welding in a Five-Inch Wrought Iron Pipe.

loops are uniform in wall thickness and strength, with no reduction of cross section, and they may be formed to fit neatly into the available space. Short lengths of pipe are utilized on various railways for the manufacture of fittings, at a saving of from 20 to 45 per cent in cost.

Wrapping Facilitated

Welded lines are coated or wrapped more readily and economically, either with material designed to protect against corrosion or for insulation purposes. The relatively uniform diameter of a welded system reduces the necessity for covering bulky fittings and thus eliminates much hand molding of insulation. Long sweep bends further reduce the labor of hand molding and the entire installation presents a much more pleasing surface area is less and the outside diameter relatively uniform. The insulation thickness over the system tends to be more even and efficient because it is sometimes the practice, in covering threaded fittings, to maintain a uniform outer diameter, regardless of the amount of insulation applied.

Practice—It is interesting to review a few of the practices employed on various railways that weld pipe lines to a comparatively large extent. One report indicates that during the past it has been the practice to make underground installations of yard air lines used for the operation of tools and the testing of train lines. One of the principal reasons for this practice was the number and size of the fittings, which would have constituted safety hazards if the lines had been placed above the ground. As

the lines aged, leaks which were very difficult to locate, became more frequent, while repairs were slow and costly, even necessitating support for the tracks.

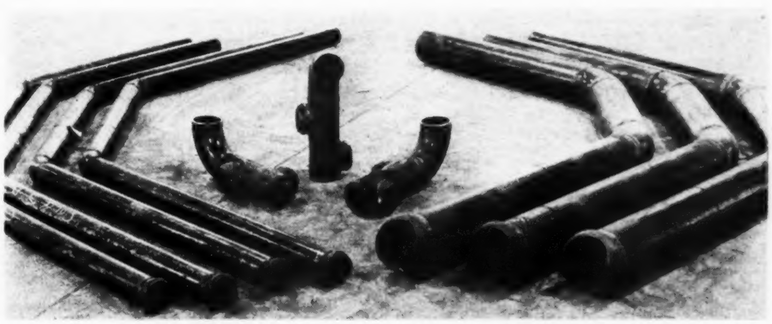
With the adoption of pipe welding, the underground air lines were largely abandoned and new ones installed above ground. Since there were no cumbersome pipe fittings, welded pipe was, in some instances, placed close to the rail, frequently, against the web, out of the way of workmen and trainmen. Such installations made it possible to use shorter air-hose, and the ready application of new outlets without disturbing the air supply in the main line.

Lines above ground and overhead, are also much easier to protect against corrosion, and as they grow older and leaks develop through deterioration, repairs may be made readily without the necessity of prolonged searches and expensive excavation. Welding is adapted especially for such use as the piping of blacksmith shop forges where long bends and reducers are easily made.

Another interesting description of a maintenance problem follows: A steam line under a concrete floor developed a leak; careful search was made until its approximate location was decided upon; a small portion of the floor was removed and it was found that the leak was on the bottom of the pipe. The steam was shut off and a small hole was cut in the top of the pipe, the leak was welded from the inside, the portion removed from the top of the pipe was rewelded, and a small patch of concrete repaired the floor on a job that would ordinarily have called for the taking up of approximately 20 sq. ft. of concrete floor, if welding practice had not been available.

Practically all of the railways that are using welding as a means of maintaining pipe lines report that there is often advantage in cutting out leaky sections of pipe and welding in short lengths of new or second-hand material. The committee received descriptions of many different unique and practical methods of making repairs by welding, which resulted in considerable economy and the resumption of service after short shut-downs.

Investigation has demonstrated the many advantages and economies of welded over threaded pipe joints; it has also shown that comparatively few railways are taking full advantage of these economies in both new installations and ordinary maintenance work. We recommend and urge the adoption of welding methods in bridge and building work as a modern development which is well worth while. The process calls for little "out of pocket" expenditure and journeymen at present on the payrolls may quickly be taught and trained to become proficient welders as an additional requirement of their positions. One western railway requires its plumbers, steamfitters and water service men to be proficient oxy-acetylene, thermit and electric welders, a rather drastic qualification for the old time "baling wire experts."



Specimens of Arc-Welded Pipes and Fittings

Organization for Welding

A permanent welding gang may not be necessary but with trained welders available a plumbing, steamfitting or water service gang may be made up at will to fit the occasion. Our reports indicate that for ordinary work a welder and one or two helpers meet the requirements, while this set-up may be augmented in proportion to the size and nature of the work at hand. On heavy terminal or long pipe line jobs a steamfitter or water service foreman is placed in immediate charge of the gang, which is usually divided about equally between mechanics and helpers, as the work demands. In some instances as many as 12 welders have been used on engine house pipe lines and on water lines as long as 18 miles.

Committee—C. Miles Burpee, (Chairman), research engineer, D. & H., Albany, N.Y.; W. H. Harrison, bridge and building master, C.P.R., Toronto, Ont., Can.; R. C. Henderson, master carpenter, B. & O., Garrett, Ind.; W. E. Pierce, bridge and building foreman, D. & H., Binghamton, N.Y.; T. E. O'Brien, bridge and building master, D. & H., Carbondale, Pa.; W. S. Rich, general foreman buildings, N.Y.C., New York City; W. A. Batey, system bridge inspector, U. P., Omaha, Neb.; Orville Stephens, bridge and building supervisor, D. & H., Green Island, N.Y.

Discussion

Chairman Burpee supplemented his report with a number of samples of good and bad welding, pointing out the reasons therefor. In opening the discussion of this report, President Benjamin stated that the economies possible through welding are so large that no railway can afford to overlook these opportunities when repairs become necessary. The Southern Pacific, he said, is beginning to select and train young men in bridge gangs in the use of welding tools, expecting that such men will become especially valuable employees, particularly in terminals. C. W. Wright (L.I.) stated that his road has been doing much welding by contract, finding it possible to get the work done cheaper in this way during recent years. He stated that he is now about to begin the welding of the pipe in three large switch heating installations, for which work he will secure experienced welders from outside organizations.

E. C. Neville (C.N.R.) stated that his road has gone extensively into acetylene welding, especially about terminals, doing all pipe connecting work in this way. R. A. Warren (S.P.) described the construction of a round house at Truckee, Nev., for which the frame was built of old 90-lb rails, welded together on the job with an acetylene torch. Snow sheds on this road are also being built with structural members of 90-lb. rails, framed on the ground. This road, Mr. Warren said, is now providing bridge gangs with oxy-acetylene equipment and has trained welders in all of its snow shed gangs and in some of its bridge gangs.

Supplementing Mr. Warren's remarks, President Benjamin emphasized the importance of having a welder in each gang to do the many small jobs that arise. W. C. Harman (S.P.) reported that he has found welding especially valuable when raising tanks, for in this way it is possible to avoid the necessity of ordering fittings in advance and awaiting their arrival. He now cuts and fits the parts on the ground without delay.

Lem Adams (Oxweld Railroad Service Co.), stated that before he left the Union Pacific, it was the

practice to train at least one, and more commonly two welders in each gang, stating that economy was shown in the repair of water service pipe lines and in rebuilding some timber treating plants. Mr. Adams stated that when on the Union Pacific, he had experienced much difficulty with leaks in air lines in train yards, with much loss of air, which leaks, when located, were repaired by welding.

In reply to a question, J. F. Franzen (Air Reduction Sales Company) stated that all but the smallest diameters of pipe should be beveled to an angle of 30 to 45 deg. before welding, to insure a good joint. He also cautioned against considering a torch as merely another tool, contending that it required a trained operator and stating that it was frequently necessary to try out several men before finding one who would make good. Supplementing this statement, W. Jones (Oxweld Railroad Service Co.) stated that a welding operator should be of the same caliber as a steamfitter or a mechanic, for the more intelligent a man is mechanically, the better welder he will be, successful welding being a matter of training.

W. E. Pierce (D. & H.) stated that it is the practice on his road to weld almost everything, including rails. He added that some 10 years ago he welded the joints and fittings of a 3-in. pipe line 5 miles long, at Oneonta, N.Y., on which no fittings were used except expansion joints, and this pipe has given no trouble in the years that it has been in service.

W. J. Wignall (A. M. Byers Company) reported that the interest in the welding of wrought iron was increasing rapidly and that the practicability of welding this material was no longer open to question.

W. A. Batey (U.P.) stated that whereas one unit of the Union Pacific system formerly had 118 men in its water service gangs, it is now operating with only 46 men, which force is not only holding its own, but actually building up the condition of the water service facilities. He attributed this in large measure to the economies following welding.

Inspection of Bridges and Buildings

in the Light of Today's Deferred Maintenance

Report of Committee

THE subject assigned to your committee implies that the period of low earnings may have resulted in some slackening of inspection and that a different method is required than during normal times. Of the more than thirty responses received to questionnaires sent out to Class I roads, every one indicates that, rather than a decline in inspections, they are being made more frequently.

The use of the words "deferred maintenance" when applied to bridges has been objected to. One bridge engineer writes:

"I do not like the words 'deferred maintenance,' as in my opinion a bridge which can safely carry the power passing over it has no 'deferred maintenance.' It is a fact that all of us have changed our practices with reference to the renewal or replacement of timber bridges. Most of us have found that a bridge can safely and economically be carried beyond the life which we formerly secured; also that by a judicious use of available second hand materials, the cost of maintenance can be materially reduced."

Inspection Important

The inspection of structures is a very important function at any time, as the safe operation of a railroad is dependent upon its thoroughness, and an economical program of maintenance can be based only upon the reports of thorough inspection of the property. During normal times the renewal of structures is carried on in an orderly manner, without waiting to secure the very last bit of safe use out of the structures. Because of the low earnings of the last few years, it has become necessary to carry structures just as long as repairs will render them safe for operation and to postpone their renewal as long as possible. Therefore, although the manner of inspection itself may have changed but little, it has become necessary to record the inspection notes in greater detail and make more frequent inspections of the structures that have been repaired. These inspection notes must be made in sufficient detail to show to what extent further repairs are advisable, with a view to postponing the greater expense of renewal.

D. T. Rintoul
Chairman

A number of railroads have consolidated divisions or even abolished the positions of bridge and building supervisors or master carpenters. As a general rule, however, those responsible for the inspection of bridges and other structures have been retained as a part of the new organization, so that proper inspections by competent men may be continued. Greatly reduced traffic, particularly on branch lines (with their subsequent abandonment), permit certain reductions in supervisory forces without in any way affecting the general inspection program.

Under present conditions, inspections may be divided into three classes:

1—For the detection of defects involving immediate safety.
2—For the detection of waning serviceability.
3—For the determination of repair work or renewals.

The responsibility for the safe operation of trains over structures rests primarily with the bridge and building supervisor (or master carpenter, as he is called on some roads), and with the division engineer. This is true even on those roads where bridge and building inspectors are assigned to each division. Curtailment of repairs and renewals throws an added burden upon these supervisory officers and it goes without saying that structures should now receive more of their personal attention and inspection than in former years when

maintenance funds were more liberal.

On those roads where bridge inspectors are a part of the division staff, complete inspection of all such roadway structures as culverts, arches, trestles, bridges, highway bridges, etc., should be made at least every three months. Additional inspections should be made at more frequent intervals where a structure calls for special attention, such as undue vibration under load, defective members, settlement or other irregularities, or where deterioration is taking place. The records of these inspections should show the exact condition of each structure and the division bridge inspector should make himself familiar with the condition of every bridge in his territory.

It is important that division bridge inspectors be permitted to cover their routine inspection without interruption by reason of other duties. Inspectors who have to act as general handy men, water-service foremen and in other capacities are likely to have so many errands forced upon them that they cannot do their inspecting properly.

Every Three Months

The bridge and building supervisor should make a complete inspection of the structures on his division at least every three months, in addition to more frequent inspections when repairs are being made to see that the work is carried on in a safe and economical manner and that sufficient repair work is being done to keep the structure safe. In addition, special inspections should be made where the condition of the structure warrants.

The division engineer, being in charge of and responsible for the safe condition and maintenance of all structures on his division, should inspect those structures showing a waning service life, in company with the bridge and building supervisor. He should see that the work of repair or renewal is of a good quality and that during periods of construction or repair proper precautions are taken to prevent accidents and to keep the structure in a condition safe for the traffic. Such general or detail inspections as may be made from time to time by the system bridge engineer or his asisstant do not relieve the division engineer or the bridge and building supervisor from responsibility or obligation to carry out all rules and regulations designed to keep the structures in a safe condition.

An annual bridge inspection is made by the system general bridge inspector, covering all structures—division by division. He should be accompanied by the division bridge inspector, the bridge and building supervisor and, on the more important structures, by the division engineer. An accurate and detailed record should be made on the ground of the condition of each structure, and the repair work, if any is needed, should be discussed with the division officers. Later a schedule should be prepared on a proper form from these notes, showing in detail what repair work is needed on each structure and whether renewal or reconstruction is recommended. One copy of this schedule should be made for the division engineer and the other for the use of the system bridge engineer. This annual inspection can serve as the basis for the bridge budget for the coming year.

On some roads the inspection of steel and concrete structures is conducted by a bridge inspection party, headed by a qualified bridge designer and usually accompanied by two assistants.

On most railroads it is incumbent upon the section foremen to examine all waterways after every heavy rainstorm or extraordinary flow of water, and if any undermining or other damage has occurred, to report it immediately to division headquarters by wire. Where there are district or floating gang bridge and building foremen, inspections should be made every month and any necessary minor repairs taken care of.

All railways have general and specific instructions covering the inspection of both timber and steel bridges. Some of these instructions are embodied in the Rules and Regulations for the Maintenance of Way and Structures, while other roads issue specific bulletins covering this inspection. The matter is of sufficient importance to reproduce a typical set of instructions in detail.

Instructions to Inspectors

1. Safety is the first consideration—then economy.

2. The inspection notes on each structure must be filled out at the structure.

3. Number the bents, spans or panels in each bridge in the direction of structure numbers on the division. Number piling in all bents and piers from left to right, designating trusses as left or right when facing away from the initial point of the road.

4. Test timber for decay by sounding with a sledge, prodding with a steel bar or boring, as may be necessary. Care must be taken not to disfigure or injure the timber by doing this and all bored holes must be plugged.

5. In making inspection of bridges and culverts, compare with notes of last year's regular annual inspection, making note as to whether or not authorized work has been performed.

6. See if the track at each end of the bridge is in good line and surface and corresponds with the line and surface of the bridge. See if the line and surface of the track on the bridge are correct.

7. Note any decayed, split or otherwise defective bridge ties. See if there are tie plates on the bridge and if they are drawn tight so that they will not rattle.

8. Note if track rails are full spiked.

9. See if guard timbers are in sound condition, bolted down tight and in correct line. See if guard rails have been provided where necessary and if they are full spiked and braced and in correct line.

10. Note condition of trestle caps, sills and bulkheads, particularly at points where other members bear against them.

11. See that bulkheads have proper space for ventilation and extend to a sufficient depth below base of rail.

12. Note if tower posts, trestle posts or piles are decayed, split or crooked and if bends stand plumb. Examine piling particularly for decay at the point where they enter the ground or water. Remember that the points of worst decay in piles may be covered by loose dirt, water or snow.

13. Examine all tower, longitudinal and sway braces on timber trestles. See if the timber is sound, bolts tight and bracing sufficient and properly applied. Observe the action of a trestle under the movement of trains to determine this, if possible.

14. See if culverts have end walls; if not, note where end walls are required. See if the flow line of the culvert is at the proper elevation and if the culvert drains itself.

15. Note the condition of culverts. In timber culverts, see if the timber is sound. In metal or masonry culverts, examine for cracks or settlement. Where new culverts are required, or old culverts need renewal, give size of opening and distance from bottom of stream to base of rail.

16. Note condition of paving.

17. Examine the condition of all masonry; note particularly signs of settlement, cracks or imperfect stones or defective concrete. Note if masonry needs pointing and see if any cracks have opened since the last inspection was made.

18. On wooden bridges see if water barrels and buckets are provided or are necessary. State the condition of such barrels as may be in position. See if they are kept filled with water and have sufficient in them to prevent freezing in winter.

19. Note that necessary ladders are provided and if in good condition.

20. If hand rail and walk are provided, note that planking is sound and nailed down and that bolts on posts are tight and hand railing is not loose.

Truss Bridges

21. Detailed report must be made of each truss bridge, referring to the following items:

(a) Examine rail surface and the alinement of track on bridges and approaches. Examine connections at floor beams, laterals and stringers, and also at all panel points of trusses, noting and reporting any defective connections which

cannot be properly taken care of and adjusted at the time.

(b) Examine all parts of the iron and steel work and report any appreciable deterioration or reduction in section of metal of any member, due to the effects of brine drippings from refrigerator cars, gases from locomotives or other causes.

(c) Report on all loose rivets in floor beams, stringers and truss connections, and also on the failure of the bottoms of posts to abut floor beams. Also report on loose hangers and nuts where they cannot be adjusted at the time. At floor-beam and stringer connecting angles, report on any indication of fracture at the root of the angle.

(d) See that all adjustable members are properly adjusted. Examine all counters and see that they are properly adjusted to a light tension and are not tighter than necessary to prevent sag or rattle.

(e) See that all truss and lateral pin nuts are in place and tight, with the threads properly checked. Examine the camber of all trusses carefully; also the alinement of the trusses and of individual compression members, particularly end posts, reporting any indication of buckling. Report on all loose rivets or indication of motion at abutting joints or compression members.

Piles Must Be Carefully Inspected

(f) See that all hanger bolts and nuts are in place, with threads properly checked and tight, and that all bridge seats are clean and have good drainage. See that rollers are in proper position, clean and free to move. Where rollers are jammed, or there is not sufficient room for proper expansion, note and report on any indication of buckling in the end panel of the bottom chord.

(g) Examine the general condition of painting, masonry, tie floor, spiking, etc. In combination or wooden truss bridges, see if tension members are so tight as to cause crushing of timber at the connections; also note any indications of counters buckling on account of being too small, or of main ties in the same panel being too tight.

(h) In Howe truss bridges, examine all timbers carefully, especially the lower chord, near the center panel points, boring them with a small auger, in such a position and direction as not to reduce the net section of the lower chord any more than necessary to enable one to determine the percentage of good timber left in the wooden members at these critical points. Do the same at the top chords near the center; also where the compression members of the trusses join the chords; after the examination is made plug auger holes which it is necessary to bore in top chord sections and struts. Examine all floor beams and stringers carefully and note their condition. Furnish sketch which shows clearly the percentage of good material remaining at each of the critical points examined, so that the necessity of renewing the timber or supporting the bridge temporarily may be passed upon intelligently.

(i) Where any condition is found demanding immediate attention, and men and material are not available, report by wire and if the defect is of such a nature as to make it unsafe to operate over the bridge, take steps to stop traffic and to notify the superintendent immediately.

Buildings

One result of the low earnings of the last few years is a greater reduction in the maintenance work on buildings than on any other single facility. During normal times only a few roads maintained a regular inspection, the majority depending on their traveling carpenters or carpenter gangs, who made periodical trips over their districts, doing all the inspection and work that was necessary, thus covering all the outlying districts and the smaller terminals.

Where special repairs were necessary, reliance was placed upon the agent, section or shop foremen to report them and these repairs were handled by the traveling carpenter. At the larger terminals carpenter gangs were constantly at work maintaining the different structures. During the last few years, there has been such a curtailment in expenditures that traveling carpenters and gangs have in many cases been eliminated and all but the most urgent and necessary repairs have been postponed.

Many Buildings Abandoned

The decline in traffic has resulted in the closing and abandonment of many buildings. Those no longer in use and for which there is little or no prospect of use, are being torn down to salvage material that can be used for repairs to buildings that still have to be maintained. In some cases they may be sold to outsiders for the salvageable materials, thus relieving the road of the cost for removal, which may in many cases exceed the value of the salvage. Many smaller structures, in need of repair and housing scattered small activities of a terminal, have been abandoned and these activities removed to larger buildings which are in good physical condition.

Under these conditions, it has become even more necessary than in the past that the inspection of buildings be made carefully and intelligently in order that expenditures for maintenance may be held to a minimum consistent with economy, both present and in the future. In order to take care of immediate repair work and to program its work to avoid costly emergency repairs, one of the large railroads has started a thorough inspection of its buildings. Such inspections should be comprehensive, including if possible all roadway buildings or at the very least all buildings in terminals and cities. Reports of the conditions found should be made on identical forms, which should be as brief as possible, depending upon supplemental notes to cover unusual types of construction and conditions. Each building should be reported on a separate sheet.

Where practicable, it is preferable that one man make all inspections and write all reports. This man should have a good general technical knowledge of all types of construction so that he can readily perceive weaknesses and determine what measures are absolutely necessary. He should be accompanied by the division representative actively in charge of maintenance operations in the field. By this method all reports will be in similar form and the conclusions as to the amount of work necessary can be determined from accumulated experience.

Discusions during inspection will generally develop the most economical method and the extent of the work and from this a rough estimate of the cost can be made and included in the report. Upon the completion of the inspection of a division it is possible to prepare an estimate of the total expenditures. From careful analysis the extent and cost of work which cannot be deferred can be determined, as well as that which can be programmed and that which may be held over until the next year or even later.

A typical report form is given here.

Building Condition Report

Location: Alhambra Division: Central
Use Car paint shop

1. Foundation—brick
2. Walls—brick
3. Roofing——corrugated steel
4. Metal parts—gutters and down spouts very badly rusted
5. Mill work—fair—doors failing—Glazing—Skylights on south side of center section very bad. Wood frames failing and broken. Sash glazing—good.
6. Paint, protective condition—fair. Appearance—fair
7. General appearance and condition—other than noted, a sound building of good appearance.
8. Floor—cement

9. Walls—brick fire walls—tin-clad fire doors
10. Ceiling—none
11. Roof Construction—East section—wood and iron trusses with bellyrod purlins, center section—wood trusses and purlins, west section—steel trusses and purlins.
12. Sanitary facilities—detached Disposal:
13. Heat—steam direct radiation
14. Light—electricity
15. Water supply—company
16. Paint, protective condition—good. Appearance—good
17. Remarks—Repair gutters and down spouts ....$ 200
Replace skylight center section south side 3,000
Repair exterior doors.......... 75
The above should not be deferred.
Replace wood skylights, center section, north side 3,000
This can be deferred until 1936 or 1937.

Although the title of this report pertains only to bridges and buildings, tunnel inspection is important and the same officers are responsible for this facility as for bridges. There are no universal instructions for the inspection of tunnels and the committee has not been able to develop information on the methods of making these inspections. On one of the large western railroads, which has a large number of timber and masonry-lined tunnels, the bridge and building supervisor is required to have an inspection made every three months, participating personally at least once yearly. The reports are transmitted to the division engineer. Tunnel inspectors have been merged with bridge inspectors and this duty is performed by the latter. In addition, the division engineer is required to make an annual inspection.

Roadmasters, section foremen, track walkers, signal maintainers and tunnel foremen (where such foremen are provided) also observe the condition of tunnels through which they pass, for the purpose of discovering and giving attention to defects.

The following rules cover the general inspection of tunnels:

1. In timber-lined tunnels the condition of the timber in each bent and the date installed should be shown in the reports. The timber in posts, foot blocks, arch segments and wall plates should be tested for decay by sounding with a sledge, prodding with a sharp bar or boring, as may be necessary, care being taken not to disfigure or injure timber; all holes must be plugged.
2. Examine the side and arch lagging to see that it is wedged tight and in proper position; sound the lagging and prod for decay.
3. Examine the condition of bents closely for possible movement of the ground or undue pressure—posts and arch segments will quickly reflect crowding or heaving ground.
4. Examine the tunnel as to drainage; see that ditches are not obstructed. In masonry, brick or concrete-lined tunnels, see that weep holes are clear and functioning.
5. Examine carefully the condition of walls, arches and paving in masonry, brick or concrete lined tunnels, for signs of crowding movement, cracking or disintegration.
6. In tunnels without lining, examine the walls and arches carefully by sounding and prodding to develop if there is any slacking, disintegrating or slippage of the rock. Loose rock that is not secure must be removed without delay and tunnel lining made safe.

Inspection Must Precede Repair Work

In conclusion, the committee finds that the inspection of structures is so important from the standpoint of safety and the budget that the necessity for trained inspectors is universally recognized. It also finds that inspections have been maintained during probably the wost depression that this country has seen.

Committee—D. T. Rintoul, (chairman), general bridge inspector, S.P., San Francisco, Cal.; J. G. Sheldrick, resident engineer, M. St. P. & S.S.M., Minneapolis, Minn; Armstrong Chinn, chief engineer, Alton, Chicago; W. E. Carnes, assistant division engineer, N.Y.C., Jersey Shore, Pa.; F. A. Armstrong, supervisor bridges and buildings, S.P. (Pac. Sys.), Bakersfield, Cal.; T. P. Soule, general supervisor bridges and buildings, N.Y.C., New York City; H. Toms, bridge and building master, C.N., Montreal, Que.; R. E. Dove, asst. engr., C.M.St.P. & P.

Discussion

In the absence of Chairman Rintoul, the report was presented by Mr. Dove.

T. B. Turnbull (Ann Arbor) explained that it is the practice on his road to inspect all bridges twice a year, in the spring and again in the fall, the following year's bridge repair program being compiled from data gathered during the fall inspection. In carrying out this program, he said, the most important and pressing repair jobs are done first and the less important repairs are made later. The necessary material for the larger jobs is distributed in advance while material for the smaller tasks is supplied from a stock that is habitually carried by the bridge and building gang.

W. F. Meyers, Jr. (C. & N.W.) described the bridge inspection practice of his road. Two bridge inspections are made annually, he said, one by system bridge inspectors and another jointly by the division engineer and the supervisors of bridges and buildings of the respective divisions. During the winter these reports are co-ordinated in the office of the bridge engineer and a detailed bridge repair program to be carried out during the following season is built up. On the basis of the program thus compiled, the necessary material is ordered sent to the various divisions. However, before the repair work is commenced, each supervisor makes a final inspection.

President Benjamin observed that it has been his experience that authority and materials for making necessary repairs are obtained more readily now than in the past. Disagreement with this statement was expressed by another member, who stated that recently he obtained authority to renew a bridge only after he had sent a letter to his superior officer, disclaiming further responsibility for the structure. He had put this bridge up for renewal for four consecutive years, he said, without success but within a week after sending the letter referred to, he received authority to renew the bridge.

After pointing to the drastically curtailed funds that have been available for the maintenance of bridges and other structures during the last several years, Elmer T. Howson (*Railway Engineering and Maintenance*) said that those responsible for the safety of railroad structures should not allow themselves to be lulled into the belief that the curtailment in maintenance expenses can be continued indefinitely without disastrous results. During the depression years, he said, the railroads have been able to make large reductions in their maintenance expenditures only because of the surplus of strength that was plowed into the tracks and structures during the prosperous years. That this surplus may even now be nearing exhaustion is evident from the fact that derailments due to defects in track are increasing. Railroad men, he said, must be on the alert for the time when the reduced level of maintenance expenditures now prevailing will no longer be adequate for the proper maintenance of the tracks and structures.

J. P. Wood (P.M.) suggested, in view of the present age and condition of some structures and the consequent high cost of maintenance, that it might be more economical to replace such structures than to keep

them in service. Mr. Howson agreed with this statement, but said that the stumbling block to the replacement of old facilities has been the initial cost of new structures. As an illustration, he cited the fact that some railroads have gone back to the use of untreated ties temporarily in order to avoid the initial cost of installing treated ties.

W. C. Harman (S.P.) explained that it was the practice on his road for the general bridge inspector or the assistant general bridge inspector to make an annual trip over their lines for the purpose of making a very detailed inspection of the bridges, while the local bridge inspectors go over the structures on their territories about once every three months. In the meantime, the supervisors of bridges and buildings inspect the structures on their respective territories as often as they find it practicable to do so.

E. C. Neville (C.N.R.) said that the practice on his road was to make an inspection of the bridges in the spring and another in the fall, the division engineer making the spring inspection and the district engineer the fall inspection. A separate inspection of all steel structures is made by specially designated persons who are familiar with the requirements of such structures. In addition to the regular inspections, Mr. Neville felt that the bridge and building supervisor should inspect the structures as frequently as he finds its possible to do so.

L. D. Garis (C. & N.W.) thought that it was a desirable practice to have the bridge and building supervisor accompany the bridge inspector on inspection trips but added that on his railroad this was not possible because the inspector devotes all his time to the inspection work, while the supervisor has other duties that require his attention. Mr. Garis favored the idea of having section foremen watch the bridges following washouts, with the idea of detecting any signs of failure that may develop. Where this practice is followed, he said, it might be desirable to give the foreman some training in bridge inspection technic.

Theodore Doll (A.T. & S.F.) said that detailed annual inspections of the bridges on his road are made by regularly assigned men from the division engineer's offices, while steel bridges are inspected in detail once every three years by a representative from the bridge engineer's office.

The Use of Treated Timber in Buildings

Report of Committee

THE use of wood in structures is usually based upon its relatively low first cost as compared with other and more permanent forms of construction. For this reason, it is more widely used in this country for building purposes than any other material. However, if wood is not properly protected from destructive agencies, the saving in first cost is soon lost, and expenditures for the maintenance and replacement of weakened or destroyed members mount rapidly.

The rising costs of lumber in building construction, as well as the cost of labor involved in its installation, have forcibly shown the necessity for greater care in the protection of the material to assure economical service and long life after installation. Probably the greatest waste of wood at present occurs through decay and insect attack. These losses can be prevented by preservative treatment.

Investigations show that decay is caused by low forms of plant life called fungi. The food of the fungi consists of certain substances in the wood, and as these are dissolved, the wood structure is broken down and attains a condition which we know as rot. The growth of fungi requires moisture, air, a favorable temperature, and food. Wood, in contact with damp ground, usually contains the right amount of moisture for the development of decay, but wood can be either so wet or so dry that fungi cannot live in it. When submerged

L. C. Winkelhaus
Chairman

in water, or kept perfectly dry, wood will last indefinitely. However, these conditions cannot be obtained generally in building construction. The most effective method of preventing decay in those parts of a structure subject to moisture, is to poison the food on which the fungi live. Wood preservatives serve this purpose.

The damage to wood in buildings by wood-boring insects is only second in importance to damage by decay. Probably the best known wood-boring insects are the termites, sometimes incorrectly called white ants. They are prevalent in all tropical and sub-tropical countries; buildings in the southeastern states, along the Gulf of Mexico, and on the Pacific coast, are generally subject to infestation by termites, while they have been discovered with increasing frequency throughout a large part of the United States.

Habits of Termites

Termites can burrow into the hardest of woods, provided they have access to moisture in the ground. Their food is the cellulose in the wood, but moisture is necessary for digestion. In burrowing into the wood, they generally follow the grain. In most cases, termites attack from the inside, and spraying with chemicals will not retard their activities. It has been definitely established that wood treated with preservatives in accordance with accepted standards of pressure treatment is immune to termite attack. A number of preservative materials are available, but the most widely known and used are coal-tar creosote and zinc chloride.

Coal-tar creosote is generally used, as it seems to be the most effective; but, because of its character it has certain limitations as applied to buildings. It has a penetrating odor, although this almost disappears in time; it cannot be painted satisfactorily, which makes it unsuitable for finished lumber, or where appearance and painting are of major importance. Therefore, creosoted lumber is used where odor is of little consequence

and painting is not necessary. For building construction, lumber treated with six to eight pounds of creosote per cubic foot by the empty cell process is recommended.

Zinc chloride is a soluble salt and is dissolved in water for injection into the wood. After treatment, the water is allowed to dry out, leaving the salt in the wood. Timber treated with zinc chloride should not be used in water, or in extremely wet locations, as the salt will leach out, thus destroying the preservative effect. This treatment is of advantage because it is clean, has no odor, is partially fire resistant, and wood treated with zinc chloride can be painted. Generally, an absorption of ¾ lb. to 1 lb. zinc chloride per cubic foot is considered good practice for building lumber.

It would not be economical or desirable to use treated lumber throughout a building. However, there are certain vital parts of a structure which are particularly subject to decay and insect attack, and these should be subjected to inhibitive treatment. Members below ground level in moist or alternately moist and dry locations, should be treated. In areas, where wood-destructive insect pests are established, or to be feared, the schedule of treatment should be increased to include structural members for a considerable height above ground level, beyond a point readily reached by the galleries that are constructed by the insects.

The use of mud sills, or other forms of wood foundations, should be avoided wherever possible, but, when unavoidable, they should be of treated material. However, lumber in parts of the structure that are subject to wear and would require replacement on this account rather than decay, does not warrant the expense of treatment.

In order to obtain information concerning the extent to which treated timber is used in buildings, a questionnaire was sent to about forty members of this association, representing railroads in various parts of the country. From the replies received, it was found that treated timber is being used rather extensively in repair and renewals, as well as in new construction.

Some roads report that treated timber has been used in the construction of the ordinary type of engine house with a wooden roof deck on framed supports. Treated material is used for the roof decking, purlins, girders, and posts. The reason given for this practice is that steam from housed locomotives produces conditions ideal for decay, which treatment is designed to overcome. Roads that do not use treated material in their engine houses and question the advantage of doing so, claim that roof members in engine houses do not decay but are "cooked" to destruction by the moist heat. It is also contended that the creosote will leach out under the prevailing hot, damp conditions under the roof. The increased fire hazard of creosoted timber in engine houses is another objection cited. However, there are many engine houses provided with creosoted wood block floors and jacking rails.

Treated timber has been used for window frames and sash members in engine houses. In one case, the material for the frames was cut to size before treatment, but was not assembled, that is, the sashes were framed and pinned together loosely with wooden dowels before treatment, and then assembled after treatment. Another road recommends against the use of creosoted material not only for window sash and frames, but also for all other mill work, stating that protection by means of paint is preferred. Creosoted timber is unsightly and makes the surfaces unpaintable, even when the creosote oil has partially leached away from the surface.

Outlying Stations

The majority of outlying freight and passenger stations are constructed of wood, and are usually set on pile butts or mud sills. These pile butts and mud sills are subject to rapid decay, unless treated. According to the data received, northern roads frequently use treated material when such decayed members are replaced. Southern and southwestern roads report that treated caps and sills are used in the original construction for protection against termites as well as decay. Joists, in damp locations without adequate air circulation, are subject to early decay if not treated.

Treated timber has been used extensively in water station construction. The use of treated wood post supports, caps, bracing, and floor joists for wooden water tanks adds a considerable number of years to the life of such members. On some roads, the entire tub is constructed of treated material, while on other roads, only the ceiling and roof of the tub are treated. There is some question as to the advisability of using treated material for the staves and flooring. Creosoted timber does not absorb water, and, consequently, the wood does not swell, as is necessary to make a water tank tight. This may be overcome, to some extent, by caulking; however, a tub made of creosoted material is very unsightly.

While houses for the storage of natural ice are becoming obsolete, some roads report that treated material is used to good advantage for sills, ceilings, and roof sheathing on account of the moist conditions produced by the melting and evaporation of the ice during the greater part of the year. While no definite data were obtained on the effect of using creosoted material in ice houses, it is possible that the creosote oil might impart an objectional taste to the ice.

Western roads maintain stock yards at practically all small stations. These facilities consist of shelter sheds, fences, chutes, gates, loading platforms, etc. Practice in the use of treated material in these facilities is not uniform. Except for those members in contact with, or below ground level, such as posts, sleepers, sills, floor joists, etc., there is apparently no necessity for using treated material. The use of creosoted material on platforms used for swine or sheep has resulted in complaints on the ground that the creosote oil in the timbers burns the feet of such stock.

In conclusion, your committee recommends the use of treated material to prevent decay, reduce maintenance, and to assist in curbing the activities of insect pests.

Committee: L. C. Winkelhaus, architect, C. & N. W. (Chairman); E. A. Harrison, architect, A. T. & S. Fe.; A. O. Lagerstrom, architect, C.M.St.P. & P.; E. L. Rankin, architect, G.C. & S.F.; Thos. D. McMahon, architect, G.N.; J. E. Cooper, bridge and building foreman, S.P. (Pac. Sys.); A. T. Hawk, engineer buildings, C.R.I. & P.; H. H. Ueckert, supervisor of structures, S.P. (Tex. & La. Lines); M. A. Berringer, bridge and building foreman, I.C.; W. G. Kemmerer, assistant engineer, Penna.; W. G. Swartz, engineer acct., Canadian National Railways.

Discussion

J. P. Wood (P.M.) reported that the only creosoted timber used in the construction of buildings on his road are the pile butts used in foundations. He added that termites were noted on his territory for the first time last summer. In discussing the termite problem, President Benjamin observed that one of the worst features about these insects is the difficulty of determining their presence, as they may honeycomb a piece of timber without giving any external evidence that they are operating in the vicinity. He cited the case of a ticket counter that became infested with termites, although their presence did not become known until the counter collapsed.

W. C. Harman (S.P.) remarked that in the territory served by his road the activities of termites are reaching an alarming stage. The only indication of their presence, he said, are the small brown pellets that accumulate wherever the termites are

operating. In discussing ways and means of preventing termite infestation, Mr. Harman recommended that the ground in the vicinity of timber structures and buildings be kept dry, and that good ventilation be provided. In woodworking shops, he said, it is important to keep the floors and the ground in the vicinity of the buildings free of wood scraps. He cited a case where termites were discovered in a thirty-year-old creosoted pile, the insects having gained entrance through a crack in the surface of the wood.

T. H. Strate (C.M.St.P. & P.) stated that termites were becoming a problem in southern Indiana and Illinois, where they were attacking bridge caps and pumping houses in particular. He added that his railroad uses no treated timber in the construction of its buildings.

The result of extensive tests made to determine what timber-treating process makes the wood most immune to attack by termites were described by J. F. Seiler (American Wood Preservers' Association). These tests have shown, he said, that pressure-treated timbers are most immune to attacks by termites. He added that treatment involving a retention of 12 lb. of creosote per cubic foot of wood should render the timber immune for from 50 to 60 years. Mr. Seiler remarked that the pellets are left only by the dry wood or flying termites, which are found along the Gulf coast and the South Pacific coast, while the subterranean termites are found in practically every state in the union. The subterranean termites, he said, eat the soft portion of the annual rings, leaving the openings partly filled with a mud-like substance. Mr. Seiler described a case where the third, fourth and fifth floors and the roof of a five-story building were attacked and severely damaged by subterranean termites. In a discussion of fire hazards, he said that tests have shown that creosoted timber is more difficult to ignite and burns more slowly than untreated wood, this being true particularly after the volatile portions of the preservative have escaped.

Mr. Seiler could not agree with the statement in the report which said that the creosote in treated timber is harmful to the hoofs of livestock. In support of his view, he cited the fact that large numbers of dairy barns are equipped with creosoted-timber floors. Referring to the statement in the report mentioning the possibility of creosoted timber imparting an objectionable taste to ice, Mr. Seiler stated that there is nothing in creosote that will contaminate ice. Where ice houses are constructed of newly-creosoted timber, he said, there is a possibility that the naphthalene in the creosote will be precipitated on the surfaces of any ice that may be present. This process may continue for several weeks, or until all of the naphthalene has escaped from the timber. The naphthalene, however, is not harmful to the ice and does not impart an objectionable taste to it, he said.

Types of Floors for Highway Bridges

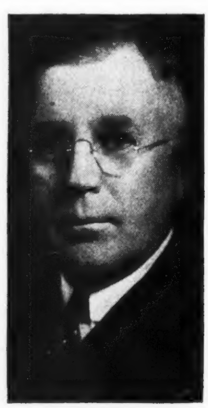
Under Various Service Conditions with Relation to Durability, Character of Sub-Floor Required, Cost and Surface Characteristics

Report of Committee

AT the 1927 convention a comprehensive report was presented on The Relative Merits of Various Kinds of Materials for Floors on Highway Bridges. The information presented here comprises a more or less general digest of data submitted by various railroads and is marked by the absence of cost data.

The bridge engineer of today is confronted by many new problems arising by reason of modern high-speed and heavy-duty motor transportation. Old bridges built for lighter and slower traffic of the horse-and-buggy days must be altered to withstand the new traffic. New bridges must embody the latest ideas, among which is a deck combining light weight with great strength and resistance to water and skidding. To the traveling public, the last mentioned quality is probably the most desirable, but to the bridge and building man, all the points named are important.

Railways sometimes find it necessary to build and pay for, and at other times to approve plans for, bridges carrying streets and public roads across railroad tracks. In all such cases the economy and efficiency of the floor construction or paving are points to be considered in the design of the bridge.



T. H. Strate
Chairman

The types of paving or flooring may be classified as follows:

Concrete Bridges

1. Concrete paving, integral with the bridge deck.
2. Concrete paving with a bituminous wearing surface
3. Concrete paving with a wearing surface of asphalt plank

Wooden Bridges

4. Common or creosoted plank, laid transversely or diagonally
5. Common or creosoted plank with steel or asphalt plank laid wheelways to reduce wear
6. Laminated planks on edge
7. Concrete slab

Steel Bridges

8. Concrete floor slab
9. Concrete floor slab with bituminous wearing surface
10. Concrete floor slab with asphalt plank wearing surface
11. Common or creosoted plank laid transversely or diagonally
12. Common or creosoted plank with steel or asphalt wheelways
13. Solid steel trough deck with asphalt filler and asphalt plank surface
14. Steel grid with concrete filling

Where the entire bridge structure is of concrete, the floors are generally of reinforced slab construction, 6 to 8 in. in thickness, resulting in a dead weight of 100 to 125 lb. per sq. ft. The trend now seems to be towards a lighter type but it must be conceded that a properly constructed concrete surface has its advantages—safety from fire, anti-skid qualities and a generally pleasing appearance.

The following is from a survey by the Portland Cement Association:

There is a noticeable dissimilarity in the present practice of applying waterproofing and providing the wearing surface on top of the structural slab. The following constructions are used: (1) Slabs without wearing surface, (2) one-course construction in which the wearing surface (usually less than one inch thick) is cast monolithically with the structural slab, (3) a wearing surface cast directly on top of a structural slab, using two-course construction, (4) a wearing surface separated from the structural slab by waterproofing without fabric, (5) a wearing surface separated from the structural slab by membrane waterproofing.

The cost increases approximately in order from type 1 to 5. Observations in the field indicate, however, that the durability decreases in the same order. Type 1, for example, appears to be the most durable and at the same time the most economical construction. The U. S. Bureau of Public Roads feels that additional thickness for wearing surface is unnecessary except possibly in a few cases such as in regions where there is considerable heavy chain traffic during particularly long periods.

Separate concrete wearing surfaces are built with an average thickness of about four inches. If the finished surface is to be crowned, the top of the structural slab is usually given the same crown.

It has been customary to construct joints in the wearing surface (a) along the center-line of the roadway, or between the lanes on bridges with more than two lanes, (b) over the regular joints, and transversely at intermediate lines in some cases on long spans. In such cases, the total length of the joints in the wearing surfaces is therefore increased over the length of joints in the structural slab underneath. This is objectionable since deck joints are relatively weak and apt to be damaged. The tendency now is, therefore, to use as few joints as possible.

The main sources of damage are (a) Impact due to wheels passing the joints, and (b) curling of the separate wearing surface in the vicinity of the joint. Free water between the two courses near the joints was observed during the removal of a top course. It was evident that the water had seeped through the joints in the top course and had penetrated some distance adjacent to the joint, the water being retained on top of the waterproofing. The consequence was that the top course shrank non-uniformly so that its top surface became slightly concave. Freezing of the entrapped water may have contributed to this condition. The curling was most pronounced at the intersection of two joints because the seepage was greatest. The load and impact from passing vehicles then broke the corners.

Curling and seepage are eliminated when the wearing surface is built monolithically with a structural slab or omitted entirely. That is why the one-course bridge deck is more durable than two-course construction. If two courses are used, care should be taken to develop the best possible bond.

Observations made during the survey pointed to the conclusion that (1) cracking in one-course construction is negligible, and (2) cracking occurs most frequently in construction consisting of two courses separated by water-proofing.

The use of monolithic or one-course construction, despite its economy and durability, has not yet become universal. In this connection it should be observed that separate wearing surfaces are used, not primarily as a means whereby bridge decks may be waterproofed, but mainly in order to facilitate construction operations. Excellent workmanship, however, was observed in a great number of bridge decks with one-course construction.

Information concerning the use of bituminous wearing surfaces on concrete bridges is scarce. The Kansas City Southern reports a few bridges with slabs covered with 2½ in. of bituminous macadam which have been satisfactory under moderately heavy traffic and have required very little maintenance. Likewise, reports of concrete bridges with wearing surfaces of brick, asphalt plank or wood block, do not indicate favorable consideration, principally due to the additional cost of the brick and the slipperiness and extra maintenance costs of the latter.

An Asphalt-Plank Floor

Plank Floors

Wooden bridges naturally constitute a very large percentage of the structures over tracks. For secondary roads where traffic is light, plank floors are satisfactory and with pneumatic tires the mechanical wear is not excessive. The old style of single flooring on wood joints presents difficulties in anchoring and direct wear on the planks. There does not seem to be much choice between pine and oak as to life for the oak, while harder, seems to have a tendency to warp and splinter. The Alton expresses a preference for a two-inch pine wearing surface on a creosoted subfloor. This road also favors laying the planking lengthwise, for the reason that the wear is only on the planks where the wheels travel, whereas when laid crosswise the wear is across the whole of the board necessitating removal of entire plank for wear on only a small portion.

Some reports have been received also on the use of runways of steel plates, asphalt planks and grid armor on bridges with little traffic and generally one way. While they serve their purpose, we do not believe they warrant much attention.

Laminated Floors

Only one report was received regarding the use of laminated floors on timber bridges—from the California State Highway department. This floor is of standard redwood timber. The construction may be described briefly as consisting of bents spaced at 19 ft. centers, with 6-in. by 16-in. by 20-ft. stringers spaced approximately 16 in. apart. The laminated floor consists of 3-in. by 6-in. SISIE material laid at right angles to the stringers. A surfacing 1½ in. in thickness completes the floor. It is interesting to note that the State of Oregon, which formerly used a laminated wooden floor is now using concrete almost entirely.

A report on the use of concrete slabs on timber bridges was also received from the California commission. The design of the structure is identical with that described, up to and including the stringers. Instead of the laminated floor, a two-inch sub-floor is installed, and this is topped with a reinforced concrete slab seven inches thick at the center of the bridge and five inches thick at the edges. Structures similar to the two types described above, have been built also of creosoted timber instead of redwood timber.

This brings us to the steel bridges, concerning which more information is available. The use of concrete slabs on steel girders is a popular type of construction. The advantages of such floors are (1) Security against fire, (2) low maintenance cost of roadway, (3) lateral stiffness, (4) protection for the steel floor system, (5) attractive appearance and safety to traffic.

Serious and costly fires have occurred in combustible bridge floors. The maintenance and renewal of roadways constitutes a large portion of the total upkeep cost of many bridges. Only the wearing course of a concrete bridge floor requires maintenance and no renewal charges need be expected over long periods because concrete does not rot or decay. Neither does it shrink or bulge.

Excessive vibration in a bridge is highly undesirable. A concrete floor adds greatly to lateral rigidity and reduces lateral vibration. A well-designed and constructed concrete bridge floor will, therefore, save part of the cost of the lower lateral bracing in a new bridge.

A concrete floor does not become water soaked and retain moisture in

contact with the steel, to promote oxidation. It absorbs the greater portion of local shocks from traffic and thus reduces impact on the floor system, and since the concentrated load plus impact usually governs the design of a steel floor system, the value of concentrated in reducing impact is important. The distribution of a concentrated load which a reinforced concrete floor will effect, will actually reduce the extra weight of metal required to carry the heavier concrete floor. The appearance of a concrete floor is pleasing. It presents an even, hard but not slippery, surface, tends to reduce skidding, and in general, has all the well-known advantages of the concrete road.

Concrete floors are often practicable on old bridges, and on this subject it seems fitting to quote a discussion submitted by the Portland Cement Association.

Obviously a concrete floor is heavier than a wooden one of the same thickness but the effect of this additional weight has often been assumed to be more important than it really is. The main trusses or girders of highway bridges have usually been designed to carry a uniform live load per square foot on the floor, or a concentrated load, or both a uniform and a concentrated load, or a partially concentrated load and a uniform load over the uncovered portion of the floor, depending upon the location of the bridge and the nature of the traffic that it may be called upon to carry. It is thus seen that only an investigation will reveal the actual effect on allowable concentrated live loads of adding to the dead load on the bridge.

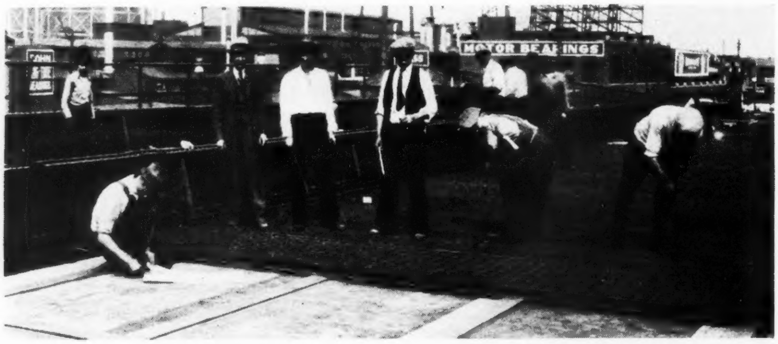
Analysis in a given case may show that the added dead load of the concrete floor will not result in any appreciable reduction in the allowable live load.

The Southern Pacific has submitted information concerning a type of steel bridge with a concrete floor on steel stringers. The stringer spacing is 7 ft. 4 in., and the floor-beam spacing is 15 ft. 8 in., 15 ft. 9 in., and 16 ft. 2 in. The reinforced concrete slab is supported directly on the stringers.

One report describes steel bridges with concrete slabs and a bituminous wearing surface. The Kansas City Southern has used 2½ in. of bituminous macadam in a number of cases, with satisfactory results under moderately heavy traffic. Little maintenance has been required. No information was received concerning concrete slab floors with asphalt plank wearing surface.

Under the head of steel bridges with timber floors, the Southern Pacific submitted a plan of a typical structure designed by the California State Highway Commission, with a laminated floor of 2-in. by 6-in. SISIE (1¼ in. off) on 4-in. by 10-in. sills placed on steel beams. The wearing surface is 2 in. of bituminous material.

Another interesting construction reported by the Southern Pacific is a bridge built over its tracks by the New Mexico Highway department. This consists of 24-in. 70-lb. CB-section beams, spaced 22 in. and tied together at the bottom by a 6-in. by 4-in. angle and covered on top with 6-in. by 10-in. nailing strips that are fastened to the beams by bent plates. The superimposed 2-in. by 4-in. planking, placed on end and surfaced to 3⅝ in., supports a compacted gravel surfacing that is 6 in. thick at the center line and 4 in. thick at the edges. The gravel surfacing was bound by an asphaltic oil, thus making a solid surface. The loading diagram provides for two 15-ton trucks, plus 30 per cent for impact.



Applying a Steel-Grid Type of Bridge Floor

Steel Floors

Steel bridges with plank floors and steel plate or asphalt runways were barely mentioned in the reports received. The Kansas City Southern reports one case where the runways on the plank were made of old conveyor belting. This was installed at small cost and gave good service. The Alton reports one bridge with 18-in. wheel treads of a patented surface armor which have not been in service long enough however, to demonstrate durability.

Under the subject of solid steel floors, information was obtained concerning the floor on an old 120-ft. through-truss highway bridge crossing the Pennsylvania-Reading Seashore Lines at Camden, N.J. This consists of transverse interlocking 8-in. channels of copper-bearing steel laid with flanges alternately up and down and welded to stringers at intervals of about six inches. Asphalt filler was packed in the alternate troughs thus formed and the entire roadway was paved with asphalt plank cemented to the alternating surfaces of steel and asphalt filler. For the sidewalks, two-inch creosoted planks were used. As the bottom chords of the trusses were badly corroded by engine gases, they were reinforced by welding on new material. This floor construction replaced a timber floor having lines of steel traffic plates or wheelways. The advantages claimed for a floor of this type are a saving in dead load, this floor weighing about 50 lb. per sq. ft., and its adaptability to old steel bridges with wooden floors but which, with a small amount of strengthening, will be good for many years service.

Steel Grid Floor

Another type of steel floor is a shallow construction consisting of a steel grid or grating welded to the bridge stringers and filled with concrete, the exposed top edges of the steel helping to take up the wear from the wheels. The mesh may be triangular or rectangular. In one design, 2¼-in. to 3½-in. longitudinal bars 6 to 7 in. apart have 1-in. bars welded between their heads (or expanded from the metal of the heads) to form a diamond mesh. Copper bearing steel is used and the concrete is filled in flush with the top of the steel mesh. To provide a base for the concrete filling, the longitudinal bars may be welded on top of a continuous steel plate. In other designs, thin steel plates rest upon and are welded to the flanges of the longitudinal bars of "I" or inverted T-sections, thus forming a base for the concrete. In still other designs, however, with bars of similar sections, the bars are laid with their bottom flanges in contact, so that the base plates are not required. In the bars of the I-section the heads or top flanges are very narrow. These bars may be 2½ to 3½ in. deep, and 3 to 3½ wide over the flanges.

With rectangular grids, the transverse members are flat bars on edge, seated in and welded to slots in the

heads and webs of the larger longitudinal bars. A three-inch floor of this kind has been used on the east approach to the upper or highway deck of the Eads bridge at St. Louis. For the roadways, three-inch bars, 4 in. apart, are used while for the sidewalks a lighter construction two inches thick is used, with 2-in. by 2-in. T-bars, about 4 in. apart, and $\frac{3}{16}$-in. by ½-in. transverse bars. In some designs, the transverse bars, instead of being flat, are of triangular section, thus forming dovetailed sockets which lock the concrete filling in place. The grids are furnished in sections ready for laying. The weight of the floor varies with the depth and spacing of the steel bars and the traffic to be carried. It may range from 40 to 60 lb. per sq. ft. It is practicable to use a special light-weight concrete to limit the weight of the floor without reducing its strength or capacity.

Steel-Channel Type of Bridge Floor

During the last four years a light-weight surface armor has been available for heavy-duty floors and trucking platforms in industrial plants, and it has been applied to bridge floors by the Chicago, Milwaukee, St. Paul & Pacific within the last two years with favorable results.

Installation of Armor

This armor, as used on the Des-Plaines Street viaduct in Chicago, was placed on a four-inch wood sub-floor on steel beams. The armor is made from copper-bearing band steel and is available in 14 and 12 gage and in three depths, ¾ in., 1 in. and 1¼ in. The ¾ in. in the No. 14 gage type is most generally used. Hexagonal openings, 1¾ in. clear, were adopted as providing the necessary traction without introducing an undesirable degree of resistance.

After the armor is assembled and anchored to the base, a binder coat of 50 per cent asphalt and 50 per cent Fortnite oil is brushed over the base and armor. The desired fill is then applied and firmly tamped or rolled flush with the top of the armor. Where the armor is applied on a concrete base to be filled with a mastic or cement mix no anchors are required.

The ¾-in. No. 14 gage armor, together with the anchors, costs approximately $0.265 per square foot, the field labor for clinching the units together and the anchoring cost $0.01, and the mastic fill $0.025, making a total cost of $0.30.

Fillers

Two types of fillers were used, one a commercial asphalt paving material, and the other a mixture consisting of 1½ parts of cement, 1 part of asphalt, 2 parts of sand and 2 parts of gravel (the latter not to exceed ¼-in. aggregate). This construction affords an excellent light-weight wearing surface under heavy-traffic conditions.

It may not be amiss to call attention to the question of corrosion by gases and smoke from engines, and the erosion by engine blast, of floors with exposed steel over the tracks, especially where the clearance above the smoke stacks is limited. The same influences may cause deterioration of concrete and eventual exposure and corrosion of the reinforcing steel. With wood flooring, there is the liability of fire caused by sparks in the engine blast. This suggests the advisability or economy of blast plates under the bridge floor as a protection from both corrosion and erosion, and fire hazard.

The committee has received information from the Service Bureau of the American Wood Preservers' Association concerning some bridge floors which, while not necessarily structures over railroad tracks, may be of interest.

The Fourteenth Street bridge across the Potomac river in Washington, D.C., formerly had a deck of the "buckle plate" type with a thin covering of concrete, topped with sheet asphalt and by 1928, this deck had deteriorated to a point that called for maintenance. This entire construction was removed and 8-in. 20.5-lb. I-beams were bolted to the stringers in a crosswise position at 4 ft. 6 in. centers. The subdivided panels of the trusses have a span of approximately 15 ft. 5 in., with deep built-up floor beams, into which the stringers are framed with the top flanges flush. Street-car rails for two tracks were laid directly on the top flanges of stringers. The new cross beams are covered with a timber floor, made up of 3 in. by 7 in. laminated pieces, securely held together with 8-in. steel spikes. The wood floor was covered with a 2-in. sheet asphalt wearing surface. The break between sections of the wood laminations above the flanges of the roadway stringers was filled with an asphalt binder, carried up flush with the roadway surface. The same material was placed around the rails, above the track stringers. The laminated deck was laid up in panels, securely bolted to cross beams and floor beam flanges to increase rigidity, after which the wearing surface of asphalt was applied. All timber was southern yellow pine, creosoted by the empty-cell process with 10-lb. retention. There has been no occasion for repair or maintenance in the seven years of service in spite of the heavy traffic to which the bridge is subjected, which is estimated to average about 22,000 vehicles per 24-hr. day.

A Surface Armour for Bridge Floors

Another Example

Another example of the reconstruction of floor systems of old steel truss bridges is the Market Street bridge in Ottumwa, Iowa. This bridge is 1,050 ft. long and has a 24 ft. vehicular roadway, with a 6-ft. walk on each side. The floor system was reconstructed in 1912 with pressure-creosoted southern yellow pine. The 3-in. by 12-in. vehicle floor was supported by steel beams under 3-in. by 8-in. nailing strips, and was covered by a wearing surface. The 2-in. by 6-in. boardwalks were carried by wood stringers and are exposed to traffic. All of this lumber was treated with 12 lb. of creosote per cu. ft. by the full-cell process. In 1930 the wearing surface was removed and replaced with 1½-in. asphalt plank, but the treated timber floor was left in place, having been found to be in good and serviceable condition after 18 years service.

Another case somewhat similar is the Abbey Street bridge in Cleveland, Ohio, where the floor was redecked in 1930 with 6-in. creosoted plank laid flat and placed directly on the I-beam stringers, to which they are held by means of U-bolts. Steel splines were used in fastening adjacent planks together. The wearing surface is provided by 2-in. asphalt planks. Through the street car tracks and the devil strip, the asphalt plank is laid transversely, while the section from the outer rail to the curb on either side is laid diagonally. The roadway carries a heavy combined truck and touring-car traffic and the floor is giving good service.

The City of Minneapolis, in 1930, replaced three old bridges across the Mississippi river, one of which is on Hennepin avenue. This bridge carries a heavy traffic, including a large number of trucks

and buses. It also carried two lines of street car tracks. This bridge consists of two symmetrical steel arch spans, each approximately 268 ft. long. Each span is composed of six steel arch ribs on which spandrel posts, set at approximately 13 ft. 3 in. center to center, support bents that carry the floor system. The vehicular roadway of the bridge is 56 ft. wide and there is a sidewalk 12 ft. wide on each side.

Decreased Dead Load

This structure was built about 35 years ago and was designed for a live load practically equivalent to the modern ten-ton loading usually employed. The original floor was of untreated plank which, at the time renewal of the deck became necessary, was replaced with steel plates covered with a heavy concrete mat. This heavy dead load constituted a severe tax on the capacity of the bridge at a time when vehicular weights were constantly increasing, so that the utility of the bridge for carrying present day traffic was becoming materially impaired. The only method of increasing the live load capacity of the bridge consisted in lessening the dead weight. This was done by removing the steel plates and concrete, and replacing them with creosoted timber. The new floor is of a laminated type from the sidewalk line to the outside of the street car tracks and on this portion, 21 ft. in width, 3-in. by 6-in. timbers were used in 9 and 12 ft. lengths so that the joints might be alternated to secure greater strength as the laminated construction was not practicable. Through the street car tracks, a creosoted plank type floor was used. At the time of removal of the old floor preparatory to relaying the new deck, approximately half the floor beams and stringers were renewed, and additional stringers were placed under the street car tracks, thus strengthening the floor system for current requirements. Two-inch asphalt planks were provided on the vehicular roadway. The sidewalk planks are for a wearing surface uncovered. The job is entirely satisfactory and it is estimated that the live-load capacity has been increased from approximately 10 to 20 tons, which loads are now being carried continuously. The bridge is good for many years of satisfactory service.

A rather unique type of floor construction is to be seen on the bascule span of the new Sixteenth Street viaduct in Milwaukee, Wis., which was provided in 1932 with a deck of creosoted timbers and planking that were framed and bored prior to treatment. The viaduct, which carries a heavy city traffic, is as wide as the street, having a 56-ft. vehicular roadway with provision for two street car tracks and two 8-ft. sidewalks. The structure was designed for passing lanes of 16-ton trucks and for two lines of 60-ton street cars. The roadway deck is composed of a sub-floor, over which a top floor of 3-in. by 6-in. tongue-and-grooved plank is laid diagonally. Dense southern pine was specified with a standard empty-cell process of treatment, and retention of 10 lb. per cu. ft. A wearing surface of 1¼-in. rubber tile was applied to the deck.

In Nashville, Tenn., the city renewed the floor of the Woodlawn Street bridge, one of the principal thoroughfares, in 1932. Built in 1885 of wrought iron, the bridge has a total length of 654 ft. and consists of three through truss spans, one deck-truss span and one short approach span.

The floor, as originally constructed, consisted of plank 3½ in. thick, supported by 3½-in. by 16-in. stringers. For many years the creosoted sub-floor planking was protected by a wearing surface of untreated oak planks. The heavy expense incurred in frequent renewals of the untreated plank wearing surface led, in 1916, to the adoption of a more durable type of surface, namely, a vitrified brick pavement on top of creosoted sub-planking. In this case it was necessary to strengthen the floor for the added dead load and at the completion of the work half the floor plank and half the stringers were of new creosoted lumber purchased that year, while the remaining half was of the original lumber placed 31 years previously.

The work in 1932 consisted of a new timber floor, except that the creosoted stringers placed in 1916 were used again in the new construction. The old treated material that had been in service for 47 years was still in a remarkable stage of preservation, but it was not considered advisable to re-install it.

In the new floor design, the stringers are 3½ in. by 16 in. in cross section. The sub-floor planking has a length equal to the width of one roadway, approximately 19 ft., thus obviating the necessity for the center joint. It consists of 4-in. by 8-in. shiplap, dressed to 3½-in. thickness. The brick wearing was replaced by a 7-in. reinforced concrete slab. Incidentally, advantage was taken of the floor removal to clean up the floor beams of the wrought-iron trusses, which showed practically no evidence of deterioration.

The resistance to skidding offered by various surfaces has been the subject of many discussions and experiments. Bulletin 120, issued by the Iowa Engineering Experiment Station in 1934, entitled "Skidding Characteristics of Automobile Tires on Roadway Surfaces," and a report by the Ohio State University entitled "Co-efficient of Friction between Tires and Road Surfaces" have been widely quoted, and are referred to briefly below. It should be kept in mind that the anti-skid value of all surfaces is higher when the wheels are turning but just before locking, than after locking. This is called the co-efficient of impending skid or maximum rolling co-efficient. It is the governing co-efficient since a sliding skid cannot take place until after impending skid values are exceeded.

Impending Skid

The Ohio tests of impending skid show that concrete has the highest anti-skid values of any type tested for speeds of 40 miles per hour and greater. According to the Iowa report the significant feature of the tests on concrete surfaces, wet or dry, was the uniformity in the results. Co-efficients for smooth-textured concrete were generally lower than that for the coarse-textured concrete. The Portland Cement Association has stated that the anti-skid values of wet concrete, which like all other wet surfaces are lower than for the dry surfaces, are high enough to permit driving on a curve having a radius of 75 miles an hour.

Steel and Wood Surfaces

Steel traffic plates and hardwood plank floors were practically as slippery when wet as Iowa mud on concrete. It was evident when running the tests on these wet surfaces that they were dangerous. Because of the abrasive action of traffic, the steel plates acquire a polished surface that offers little resistance to skidding when wet. It is possible that an open-mesh design with fairly sharp edges would improve their skidding resistance. The wood planks absorbed a large percentage of water near the surface, and it was not possible to squeeze all the water out between the tire and the plank. Under these conditions the water had a greater lubricating effect on wood plank than on certain other surfaces, and, therefore, the co-efficient was low. Tests on wood plank floors covered with a tar mastic indicated that this treatment will raise the co-efficients to the same value as that obtained for a similar type of surface on a macadam base.

Asphalt Surfaces

The tests on asphalt plank indicated that the co-efficients for the mineral-surface plank installations were notably higher than for any of the other installations. In fact, the co-efficients for this surface when wet were slightly higher than the co-efficients obtained on the three portland cement concrete surfaces that were tested wet.

This was no doubt due to the fact that the concrete surfaces tested were smooth textured and not rough, as reported in some cases. Further, the surface consisted of round, mortar coated sand and not a sharp exposed sand like that found on some of the bituminous sections tested.

The anti-skid values of bituminous-type roads are very low where the bituminous material "bleeds" or where such a fat mixture has been used as to fill all surface voids completely. Open textured "non-skid" bituminous types close up under traffic and must be rebuilt at frequent intervals in order to maintain their non-skid characteristics.

The cost of maintaining the various types of wearing surfaces on bridges is an important item, but is more or less indeterminate unless the supporting structure is of sufficient rigidity to make the entire construction comparable with the roadway off the bridge. There is no doubting the fact that the largest single factor in causing surface failures in bridge floors is vibration or movement of the structure under traffic. It is obvious that a comparison of two identical floor constructions, one on a rigid structure and the other on a non-rigid structure cannot be made fairly. If all conditions are assumed to be equal, it may be proper to compare surface maintenance costs of highway systems, and in this connection the committee cites the publication of the Portland Cement Association entitled "Road Maintenance Costs," which is based on records of 18 states for periods varying from 3 to 14 years. This statement gives the average upkeep cost per mile per year on the total mileage maintained but does not include all costs of retreatment and other periodic maintenance charges. The figures are strongly in favor of concrete as compared with bituminous surfaces, but no comparisons with asphalt plank or timber surfaces are available.

Committee—T. H. Strate, (chairman), division engineer, C.M.St.P. & P., Chicago; F. C. Brackett, supervisor bridges and buildings B. & M., Boston, Mass.; S. T. Corey, assistant bridge engineer, C.R.I. & P., Chicago; J. S. Hancock, engineer design, D. T. & I., Fordson, Mich.; C. S. Heritage, bridge engineer, K.C.S., Kansas City, Mo.; C. E. Horrom, supervisor bridges and buildings, Alton, Bloomington, Ill.; A. C. Irwin, manager railways bureau, Portland Cement Association, Chicago; J. H. McClure, bridge and building master, C.N.R., Moncton, N.B.; T. W. Pinard, engineer bridges and buildings, Penna., New York City; O. F. Rowland, construction engineer, D. & H., Albany, N.Y.; E. E. R. Tratman, consulting engineer, Wheaton, Ill.; C. F. Weir, supervisor bridges and buildings, P.M., St Thomas, Ont., Can.

Discussion

N. Johnson (C.G.W.) described the experience of his road with laminated decks. Originally, he said, 2-in. by 4-in. timbers laid on edge were used. It was soon found, however, that such floors were to light and short-lived; therefore, the 2-in. by 4-in. timbers were discarded in favor of 4-in. by 4-in. pieces. These too were found unsatisfactory and the practice is now to use 3-in. by 6-in. timbers of untreated material. Mr. Johnson reported that floors built of the 3-in. by 6-in. timbers have been in service for five years and have proven entirely satisfactory.

C. W. Wright (Long Island) reported that the creosoted wood block floor of the Queensborough bridge in New York is now being replaced with asphalt planks, the reason being that a large number of accidents caused by the skidding of vehicles took place on the wood block floor. Formerly, he said, the floor on this bridge was laid with a trough but since this proved harmful to automobile tires the new floor is being laid without a trough.

J. F. Seiler (A.W.P.A.) described a new type of composite floor, in which concrete is placed over a laminated floor in such a manner that a monolithic structure is obtained. In this type of floor the laminated portion is constructed of pieces of two different widths placed alternately in order to provide longitudinal grooves, or, when using pieces of the same width, a similar affect is obtained by placing alternate pieces so that they protrude above the intermediate members. Transverse plates are then driven into the grooves. With this type of construction Mr. Seiler pointed out that the sliding of the concrete floor is prevented and monolithic action is obtained.

President Benjamin described the concrete floor which is to be placed on the San Francisco-Oakland Bay bridge. Using a light-weight aggregate, he said, the concrete will have a much lower weight per cubic foot than ordinary concrete. The reinforcing for this floor, he added, is to consist of welded steel trusses about 6 in. high, which are to be welded to the bridge stringers in order to prevent them from shifting during the placing of the concrete. He stressed the fact that, if it is possible to decrease the weight of concrete by using lighter aggregates, one of the principal objections to the use of this material in floors.

Bridge and Building Supply Men's Exhibit

THE exhibit conducted by the Bridge and Building Supply Men's Association has become an important feature of the annual conventions of the American Railway Bridge and Building Association, for the materials and appliances shown are of vital interest to officers in charge of railway bridges and buildings, as well as water supply and other service facilities. This year's exhibit was more than usually instructive and educational in character by reason of the display of the materials and appliances themselves rather than photographs and literature. It was also arranged effectively in the Tower room of the hotel.

The officers of the Bridge and Building Supply Men's Association, who were responsible for the preparation and conduct of this year's exhibit, were President, B. S. Spaulding, Fairbanks, Morse & Co., Chicago; vice-president, J. W. Shoop, Lehon Company, Chicago; treasurer, B. J. Wilson, Pocket List of Railroad Officials, Chicago; secretary, L. F. Flanagan, Detroit Graphite Co., Chicago; and the following directors—W. S. Carlisle, National Lead Co., Chicago; J. H. Bracken, Celotex Co., Chicago; C. H. Johnson, Fairmont Railway Motors, Inc., Fairmont, Minn.; A. J. Filkins, Paul Dickinson, Inc., Chicago; T. G. Windes, National Aluminate Corp., Chicago; George R. McVay, Ruberoid Company, Chicago; and S. A. Baber, honorary director.

At the annual session on October 17 the following officers were elected for the ensuing year: President, Mr. Shoop; vice-president, Mr. Flanagan; secretary, Mr. Carlisle; treasurer, D. A. Hultgren, sales manager, Massey Concrete Products Co., Chicago; directors, G. C. Mills, Zitterell Mills Company, Webster City, Iowa; Earl Mann, E. A. Mann Associates, Chicago, and K. T. Batchelder, manager railroad sales, Insulite Co., Chicago.

The names of the companies participating in the exhibit, together with the names of their representatives and the nature of their exhibit follow:

Exhibitors

Arrow Tools, Inc., Chicago; forged tools, safety retainers, riveting hammers; H. J. Trueblood and N. W. Benedict.

Barrett Company, New York; rolled roofing, paint, roofing cement; M. J. Rotroff.

Binks Manufacturing Company, Chicago, paint spray equipment; J. E. Schabo.

Celotex Company, Chicago; wall-board, hard tile and insulation; rock wool, vapor proof low tension insulation; D. J. Carmouche, H. A. Winandy, J. H. Bracken and C. W. Young.

Dearborn Chemical Company, Chicago; rust preventives; E. M. Converse, A. C. Moeller, C. C. Rausch and J. A. Crenner.

Detroit Graphite Company, Detroit,

Mich.; literature on rust prevention and paints, and samples of paint colors; Luke F. Flanagan and J. R. C. Hintz.

Paul Dickinson, Inc., Chicago; smoke-jacks, cast iron chimneys, drain heads and ventilators; A. J. Filkins.

Joseph Dixon Crucible Company, Jersey City, N.J.; paints, graphites and graphite products; E. C. Bleam.

Dug-Norton Manufacturing Company, Pittsburgh, Pa.; bridge and building bridge jacks; C. N. Thulin and E. E. Thulin.

Fairbanks Morse & Company, Chicago; catalogs on pumps, turbines, Diesel engines, standpipes, electric motors and motor cars; E. C. Golloday, E. F. Kultchar, W. L. Nies, B. S. Spaulding and C. H. Wilson.

Fairmont Railway Motors, Inc., Fairmont, Minn.; literature on motor cars and work equipment; C. P. Benning, Kenneth Cavins, Arthur Fletcher and C. H. Johnson.

Ingot Iron Railway Products Company, Middletown, Ohio; multiplate pipe and paved invert pipe; W. R. Greenawalt, J. L. Young and J. R. Wilks.

Insulite Company, Minneapolis, Minn.; literature and samples of insulation; K. T. Batchelder, C. W. Hansen and C. S. Johnston.

Johns-Manville Sales Corporation, New York; samples of transite asbestos wood (flat and corrugated), asbestos roll roofing, standard asphalt bridge plank, mineral surfaced plank, built-up roofing and waterproofing, transite pipe, flooring materials; C. S. Clingman and T. O'Leary, Jr.

Materials Replaced Catalogs in the Exhibit

Koppers Products Company, Pittsburgh, Pa.; built-up roofing, waterproofing materials; S. J. Katz and H. L. Stockdale.

Lehon Company, Chicago; aluminum paint, insulating paper, asbestos shingles and asphalt roof coating; Tom Lehon and J. W. Shoop.

Mall Tool Company, Chicago; concrete vibrating and rubbing equipment, sump pump, portable saw, grinder, disc sander, wire scratch brush; F. A. McGonigle, Merle Elrick and A. W. Mall.

Earle A. Mann & Associates, Chicago; streamline pipe and fittings, copper pipe and fittings, valves and paint spray equipment; Earle A. Mann, A. A. Walker and W. F. Weber.

Massey Concrete Products Corporation, Chicago; photographs of concrete highway crossings, culvert pipe piling and cribbing; Ross Clarke and D. A. Hultgren.

National Lead Company, New York; structural paints and anchoring specialties; W. S. Carlisle, Otto Meyer, F. M. Hartley and A. H. Sabin.

George P. Nichols & Bro. Inc., Chicago; unit assembly of controller with resistance and switch cabinet, photographs of turntable tractors; S. F. Nichols, B. F. Goldman and G. M. Shearer.

Otley Paint Manufacturing Company, Chicago; pigments, paint panels, paint vehicles; E. Van Patten and W. A. Otley.

Oxweld Railroad Service Company, Chicago; cutting and welding torches, welding outfits with cylinders and regulators, paint burning outfit, welded specimens; F. C. Teichen, Lem Adams and D. H. Pittman.

B. S. Spaulding
President

L. F. Flannagan
Secretary

Patterson-Sargent Company, Cleveland, Ohio; paints; George W. Anderson and W. H. McBride.

W. W. Patterson Company, Pittsburgh, Pa.; wood and steel tackle blocks; W. W. Patterson, Jr.

Pittsburgh Plate Glass Company, Newark, N.J.; paints and water-proofing; J. G. Mowry, J. E. Leonard, C. S. Gush and W. T. Carey.

Pocket List of Railroad Officials, New York; copies of publication; B. J. Wilson.

Railway Engineering and Maintenance, Chicago, copies of publication; E. T. Howson, H. A. Morrison, G. E. Boyd, H. E. McCandless and M. H. Dick.

Ruberoid Company, New York; asbestos and asphalt, shingles and roofing, asbestos pipe covering and insulating materials; T. N. Dantz and G. R. McVay.

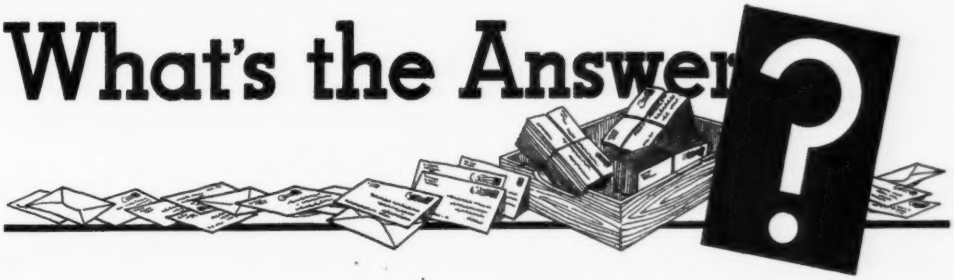
Teleweld, Inc., Chicago; welded plate samples; C. W. McKee and A. M. Wood.

United States Gypsum Company, Chicago; paints, roofing, insulation and wallboard; F. C. Vandervort.

U. S. Wind Engine & Pump Company, Batavia, Ill.; samples of wood tanks, steel towers, float valves, windmills and Curtis pumps, and literature on tank fixtures and water columns; C. E. Ward.

Zitterell Mills Company, Webster City, Iowa; G. C. Mills.

The Exhibits Were More Comprehensive Than Usual



Limit on General Track Surfacing

How late in the fall should general track surfacing be permitted? Why?

Depends On Latitude

By W. H. Sparks
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

The time limit for general surfacing will depend largely on the part of the country in which the work is being done, being much earlier in northern than in southern areas. In fact, in some districts in the South it is customary to do the bulk of the general surfacing during the winter, while in the arid regions of the Southwest, the track forces are at the minimum during the hot summer months and at the maximum during the winter.

I assume, however, that the question relates particularly to conditions where freezing may be expected normally around December 1. On this basis, I believe that October 1 should be set as the latest date for general surfacing; I prefer to advance this date two or three weeks. Any track that has been given a general raise is certain to settle, and this is likely to be more pronounced if tie renewals have been heavy and the ties have been spaced.

If the general surfacing is stopped by October 1, or preferably a little earlier, the track will be given time to settle and solidify before freezing weather. Likewise the track forces will be able to iron out those irregularities of surface which develop by reason of the fact that settlement is rarely uniform. For this reason, the period between the cômpletion of the general surfacing program and the onset of winter should be devoted to spot surfacing to keep the track smooth and insure that it will go into the winter season in good line and surface.

During the last five or six years, by force of circumstances, many of us have broken away from what was formerly considered to be orderly procedure in track work. The result is that we are not always following what we know to be good practice with respect to the time for doing certain tasks. If a track needs general surfacing, we surface it when we can get the forces to do the work, and this is not always during the "regular season" as was our custom.

Sometimes it is best to carry on general surfacing until freezing occurs. In other cases it is better to do as much spot surfacing as circumstances will permit, and carry the track over into the following year without a general raise. In any event, it is not debatable that under no condition, except in emergencies, should track be surfaced after frost has entered the ballast and roadbed. Ballast that is worked after it is frozen is almost certain to churn the following spring, making it difficult if not impossible to hold either line or surface.

Can Be Continued Late

By C. G. Fulnecky
Assistant District Engineer, New York, Chicago & St. Louis, Frankfort, Ind.

Like many questions relating to track maintenance this is one to which only a general answer can be given, primarily because of the varying climatic conditions throughout the country. However, when necessary to surface track out of face, the work may be permitted to continue until a crust freezes on the ballast or until frost begins to appear under the ties. Track should not be surfaced when there is frost under the ties. This is especially true where the ballast has become foul or the ballast material is cinders.

Whenever surfacing is permitted to continue until late in the season, there is a possibility of frozen ballast being tamped under the ties, which will result in uneven settlement whenever the weather moderates enough to cause this ballast to thaw. Again, surfacing while the ballast is frozen results in a large number of pumping joints and churning ballast. Furthermore, when general surfacing is per-

Send your answers to any of the questions to the What's the Answer editor. He will welcome also any questions you wish to have discussed.

To Be Answered In January

1. *In view of the recognized value of treated ties, is there now any advantage in the use of dating nails? Why? If so, what records should be kept of the dated ties, and by whom?*
2. *Where it becomes necessary to bore holes in treated timber or piles in the field, what means should be employed to protect the untreated wood that is exposed?*
3. *Is it more difficult to gage new rail where canted tie plates are installed? Why? If so, what can be done to overcome the difficulty?*
4. *Is there any advantage in insulating the floors of frame stations and office buildings? How can this be done? What precautions are necessary?*
5. *To what extent and in what way should men on snow duty be expected to protect themselves against accident during storms? What supervision should be exercised with respect to safety?*
6. *What are the relative advantages of poured-lead and lead-wool joints for cast iron pipe? How should each be made?*
7. *What methods should be employed in disposing of cinders during winter weather?*
8. *What are the relative advantages of steel or wrought iron plates and concrete slabs for the floors of ballast-deck spans?*

mitted late in the season, other work on the track is usually neglected and the remainder of the track not involved in the surfacing may be allowed to freeze solid without the surface and line having received the proper attention. The result is that the track remains rough all winter and shimming becomes necessary to remove as many of the inequalities as practicable.

Unless conditions make it imperative, surfacing should not be permitted to continue into freezing weather, although it is not so objectionable if clean stone or slag is being used as ballast. For the reasons given, the surfacing should be discontinued early enough to permit the section forces to get the remainder of their track in good line and surface before freezing weather forces them to stop.

Close on October 1

By J. B. Kelly
General Roadmaster, Minneapolis, St. Paul & Sault Ste. Marie, Minneapolis, Minn.

Surfacing should not only be permitted, but should be encouraged, up to the time that the ballast is frozen permanently, provided conditions are such that surfacing is required to put the track in the best possible shape for winter. On the other hand, in the Northwest, it is more economical to close general surfacing not later than October 1. Even after that date, however, spot surfacing is necessary on most track until about November 10, to insure that it will have good riding qualities before it is solidified by frost. This will eliminate the necessity for a certain amount of shimming to remove surface irregularities not connected with heaving, which disturb smooth riding far more when the roadbed and ballast are frostbound than when they are free from frost. Keeping the track in good surface promotes safety, lengthens the life of rail, track fastenings and ties, and decreases damage to rolling equipment. It is far better to have the track surface smooth before freezing, even if surfacing must be allowed to continue beyond the usual limit, than to be under the necessity of smoothing it after the track freezes.

Must Have Time to Settle

By A. L. Schalbrack
Section Foreman, Minneapolis, St. Paul & Sault Ste. Marie, Amherst, Wis.

Track that has been raised out of face always settles. The amount of this settlement depends on several factors, including the height of the raise, the amount of tie spacing that has been done; if the raise is light, the number of ties that have been renewed may also have some bearing. If settlement were uniform, the fact that settlement occurs would be unimportant; it is because the settlement is not uniform that it becomes important, since unequal settlement creates rough track.

If general surfacing is continued up to the time the track begins to freeze, the spot surfacing necessary to overcome the uneven track cannot be done, although the settlement will continue even after the ballast is frozen. The result will be that the track will be rough all winter and this condition is likely to become worse in the spring as the frost leaves the roadbed and ballast. Furthermore, if an attempt is made to smooth the track by tamping the ties after the ballast is frozen, one will invariably have churning ballast as soon as the spring rains set in.

For these reasons, it is obvious that general surfacing should be stopped early enough in the fall to insure that the track will be fully settled and consolidated on its new bed before freezing starts. Normally, the time required to obtain full settlement is also sufficient to enable the track forces to do the spot surfacing that is necessary to keep the track in smooth-riding condition and thus insure that it will go into the winter in good condition with respect to line and surface.

Facing-Point Guard Rails

What advantage, if any, is there in the use of a guard rail ahead of a facing-point switch in high-speed track? At what distance and on which side of the track should it be placed?

Should Be Close

By O. H. Carpenter
Roadmaster, Union Pacific, Rawlins, Wyo.

If the stock rail has been bent properly and is being maintained as it should, I see no necessity for the use of a guard rail ahead of the points in high-speed tracks, unless the turnout leads off from the high side of a sharp curve or there are other conditions which are likely to cause severe lateral thrusts against the stock rail at the switch.

Where a guard rail is considered necessary and the type that is commonly used at frogs is to be employed, it should be placed next to the straight running rail, that is, opposite the stock rail, and the flangeway and gage so adjusted that wheels passing through the flangeway will hold the opposite wheel on the axle away from the closed point. This must be done in such a way, however, that there will be no shock delivered to the wheel when it enters the flangeway; otherwise, it will result in a bad-riding condition for trains. In fact, I consider that this is the most undesirable feature of the use of guard rails at switch points, because if they pull the wheel away from the point suddenly, it cannot fail to transmit a shock to the equipment when the train is traveling at high speed.

If a guard rail is to be used, it should be placed as short a distance ahead of the point as practicable and still avoid interference with the operation of the switch. Otherwise, wheels may be given the time and space necessary to permit them again to crowd over against the stock rail and point after they have emerged from the flangeway.

Does Not Favor Guards

By District Engineer

While there are some conditions which make the use of switch-point guard rails desirable, I do not favor their use in high-speed tracks, as a general practice. It is my settled belief that, in general, all of the protection to the switch point that is needed can be provided by other means. While it is true that switch points wear, sometimes more and faster than they should, proper construction and good maintenance will go a long way toward minimizing both the amount and rate of wear. A switch-point guard rail should never be installed as a substitute for either good design or proper maintenance.

In many instances the wear on the switch point is accelerated by poor housing. This can be overcome by giving the stock rail a proper bend. In special cases, the stock rail can be milled in such a way as to provide a better housing than is secured by the usual bending. Giving the stock rail a reverse bend to provide this housing should not be permitted in high-speed main tracks.

Another cause for wear on the point is the practice of allowing badly worn

stock rails to remain in service. A new switch point should never be applied to a worn stock rail; it is far better to change out the stock rail when the point needs renewal than to apply the point against a rail to which it cannot be made to fit properly. The same observation applies to the point itself. When a switch point is worn enough to need some form of protection, it should be renewed; when a stock rail requires renewal, the point should, in general, be renewed also. Thin and slightly open points are sometimes cited as reasons for needing guard rails. As already suggested, the worn point should be replaced before a guard rail becomes necessary. Slightly open points should be corrected by proper maintenance.

A guard rail ahead of the switch point is sometimes desirable where the turnout leads off of the high side of a curve. While it is not always practicable and is sometimes impossible from the standpoint of reasonable cost, it is far better to shorten or lengthen the siding enough to bring the turnout on tangent. The track structure should be kept as simple as consistent with service requirements. The application of guard rails where they can be avoided merely adds to the complexity of the track construction and increases both capital investment and maintenance costs, without any corresponding compensation being realized.

Where a guard rail is applied, it should, obviously, be placed next to the rail opposite the point that is to be protected. It should also be brought as close to the switch as clearance requirements will permit, to minimize the opportunity for the wheel flanges to shift and thus crowd against the switch point after they have emerged from the guard flangeway.

Drainage Through Culverts

What action should be taken by the section forces at this season to insure proper drainage through culverts and in longitudinal ditches during next spring's rains?

Clean All Channels

By J. C. Patterson
Chief Engineer Maintenance of Way, Erie, Cleveland, Ohio

At this season, certainly before freezing weather, the section forces should remove not only all driftwood and other rubbish that has accumulated about the openings of culverts, and the channels for sufficient distance above and below, to insure a free flow of water into and from the culvert, but all debris that may have lodged in the culvert itself. All longitudinal ditches should be restored to their original cross section and vegetation should be removed to provide for unobstructed flow of the water they may be called on to carry.

Get Water Away Quickly

By W. H. Sparks
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

Many of our ditches have not been given the attention in recent years that their importance warrants. This has not been due to any intentional neglect or indifference on the part of either local or supervisory officers. These men are just as keenly aware as ever of the need for better attention to their water courses, but because of limited appropriations, it has been necessary for them to limit their activities more and more to track work, doing only such other work as is most necessary. For this reason, in not a few cases, the cleaning of water courses has been left until winter and, in some instances, until spring, at which times the force is seldom sufficient to do all of the channel conditioning that is needed on some sections, although on others, where only a small amount of work is required, it may be done without difficulty.

Where the regular program can be completed in time to permit attention to be given to the water courses at this season, the first thing is to burn all weeds and grass which have grown in the channel and accumulations of leaves which have lodged therein. Then remove all logs, old ties, large stones and other debris which might wash under bridges or into culverts or otherwise obstruct the channel. Channels leading into and away from culverts should be straightened, and deepened if necessary, and the culverts themselves should be cleaned, for freedom of flow is an important factor in eliminating water trouble.

Ditches parallel with the right of way should be given the same treatment. If they are outside of the right of way, it may sometimes be advisable to get the owner's permission to do the cleaning with company forces, for if the owner himself does not do it, the cost to the railway of using its own forces may later be returned many fold as a result of the elimination of high-water hazards.

Cleans After Every Rain

By W. E. Tillett
Assistant Foreman, Chesapeake & Ohio, Maysville, Ky.

In the territory where I am located, heavy rains are not unusual, and as there is a rapid runoff we find it desirable to give more attention to our culverts than should be necessary in flatter country. For this reason, we make it a practice to examine and, if necessary, clean out our culverts and longitudinal ditches after every heavy rain, to insure that at no time will there be a sufficient accumulation of debris to impede the flow of water.

In addition, we find it quite necessary to do a general job of cleaning in the fall. At this time we destroy all vegetation, logs, brush, etc., which are in or threaten to get into the channels. We also straighten and deepen these channels, where necessary, removing small bars of mud and sand which have been deposited during the year.

Keep Drainage Open

By L. G. Byrd
Supervisor of Bridges and Buildings, Missouri Pacific, Poplar Bluff, Mo.

A complete clearance of all obstructions from channels, culverts and pipes, including longitudinal ditches and all other waterways which may in any way affect the safety of the track or roadbed, is very important, especially during the late winter and early spring, when high water is most common. It is a poor time to undertake the work of cleaning waterways, however, when floods are near at hand or have already arrived, for which reason, the fall season is the best time to do this work.

Late in the fall, vegetation, leaves, brush, tree tops and logs are usually dry enough to burn readily, and flow is generally at its minimum, so that such excavation as may be necessary to straighten or deepen channels can be done most easily and cheaply. At this time, small bushes, grass and weeds which have grown in ditches and around the inlets and outlets of culverts, as well as accumulations of leaves and other debris, should be burned, for they not only interfere with the flow of the water, but may be washed to the inlet of a culvert and block it completely. Logs, tree tops and old ties found in the channel

should also be burned or moved to the down-stream side of the roadway.

It is our practice to remove all rubbish and dead vegetation from longitudinal ditches and from channels leading to and away from culverts and other drainage openings, and to clean culverts, during September and October. This insures a free runoff of flood water during the rainy season. We also require frequent inspection of waterways during the remainder of the year to know that the channels have not suffered any unusual obstruction and are capable of handling any flow that may be expected.

Protecting Steel with Fuel Oil

What are the advantages and disadvantages of applying locomotive fuel oil to those parts of steel bridges which are particularly subjected to accumulations of dirt and cinders? How frequently should it be applied and by whom?

Road Oil Effective

By T. P. Soule

General Supervisor Bridges and Buildings, New York Central, New York

Where for any reason it is difficult or impossible to keep steel bridges properly protected with paint, it is my experience that the oiling of those parts that are particularly subjected to accumulations of dirt and cinders, and therefore to corrosion, can be done to advantage. I am not familiar with the use of locomotive fuel oil for this purpose, but am familiar with the use of low grade oils having a high asphalt base, of the type commonly known as road oil, and have witnessed its effective application to many structures. It is my considered opinion, however, that the road oil, which costs approximately the same as fuel oil, is a better protective material for those parts of steel bridges which are particularly subject to the accumulation of dirt and cinders, than the thinner and more volatile locomotive fuel oil.

Frequent application of the road oil prevents further corrosion, loosens and removes rust and scale which are already present, prevents cinders and moisture from gaining contact with the steel surface to which it is applied and, if used for this purpose, will keep expansion rollers and plates lubricated so that expansion and contraction can take place freely in the structure. The exterior surface of the film of road oil sets or hardens quickly after it is applied, but the remainder next to the steel remains liquid or semi-liquid for a long time. As a result, dirt and cinders do not adhere readily to the surface of the protective film, as I believe will occur where locomotive fuel oil is used as a protective coating.

Oil of this type should be applied at least once a year, and it would probably be better to make two applications if a force is available to do so. It can be applied by a small gang, consisting preferably of one experienced bridgeman and two laborers; working progressively over the division. Before making the application, all accumulations of dirt and cinders should be removed from those parts of the structure that are to be oiled, but it is not necessary that the same care be exercised to obtain clean surfaces, that would be necessary if paint were to be applied. I know of no disadvantages that may accrue through the application of this type of road oil for the purpose under discussion.

Has Been Discontinued

By G. L. Staley

Bridge Engineer, Missouri-Kansas-Texas, St. Louis, Mo.

Fuel oil was formerly used as a means of protection on our steel-bridge floors, but was discontinued about 15 years ago. I do not now recall the reasons for starting the practice or the immediate reasons for its discontinuance. For this reason, I am unable to speak from recent experience, but there are certain fundamental facts which have a bearing on the question, which must be given consideration in connection with the prospective use of this material. To be of any value as a protective coating for steel surfaces, the locomotive fuel oil must, of necessity, be applied to clean metal. This will necessitate cleaning the structural members in the same way and with the same thoroughness as would be done for paint or any other form of protective coating.

It is well known that the life of an oil film on metal surfaces is short, as compared with that of a good quality of paint. Owing to the action of the sunshine and weather, the volatile components of the oil soon evaporate, leaving a residue which remains on the surface as a thick gummy film which collects dirt from the atmosphere and from train droppings and cinders. Eventually it dries out completely, leaving a caked but porous covering through which moisture seeps readily to start hidden corrosion.

For these reasons, the actual protective life of fuel oil will be short unless the surface is cleaned and oiled every few weeks. Since the major part of the cost of any structural-steel paint job is the cost of cleaning the metal surfaces and of applying the paint, while the cost of the material is small, a short-lived covering is always the most expensive. For these reasons the only advantages that I can see for the fuel oil are the ease of application and the practically negligible cost of the material.

If used, it should be applied by the regular division bridge gangs, as men unaccustomed to working from scaffolds off of the ground seldom do economical or satisfactory work.

Depends on Grade of Oil

By General Bridge Inspector

There are places on many bridges where it is practically impossible to maintain a protective coating of paint. In part this is due to the fact that they are so difficult of access that the surfaces cannot be thoroughly cleaned of rust and scale before the paint is applied. For the same reason a poor job of painting is usually done. Another condition, often occurring in these inaccessible places, as well as on surfaces that are readily accessible, is that accumulations of cinders and other foreign matter quickly form to hold moisture and destroy the paint film.

Under these conditions any attempt to keep the surfaces painted is expensive, and it is doubtful whether they are ever adequately protected against corrosion. Locomotive fuel oil, that is crude petroleum or mixtures containing a large percentage of crude petroleum, have not proved satisfactory as a protective coating, because of the large percentage of volatile constituents, which are soon driven off when the oil is exposed to the atmosphere. The residue, which consists of the heavier and less volatile constituents, becomes a gummy mass which catches and retains any dirt that comes in contact with it. This residue dries out eventually and becomes a brittle film which is relatively porous, so that moisture readily penetrates to the underlying metal, and has little adhesion to the surface it was intended to protect.

On the other hand, a petroleum refinery product, commonly known as road oil, although each oil company has a special designation, containing about 65 per cent of asphalt, has been used with marked success for the purpose indicated. The surfaces must be cleaned before application, although not so carefully as with paint as the oil loosens the scale and rust. Since this oil is a product of distillation, it does not dry out readily. Furthermore, the asphalt forms a waterproof coating which protects the surfaces from moisture and those gases which are so harmful to railway structures.

Water Barrels on Bridges

What means should be employed to insure that water barrels on bridges will not freeze during the winter? Who should be held responsible for caring for them?

Use Common Salt

By Armstrong Chinn
Chief Engineer, Alton, Chicago

Water in barrels on bridges may be kept from freezing during the winter by the addition of approximately 100 lb. of fine salt to each barrel. At the time the salt is added, special care should be exercised to see that it is thoroughly dissolved; otherwise it will settle to the bottom and be of little value. It is well to keep a wooden paddle in each barrel, with which to give the contents an occasional stirring to keep the salt in solution.

The section foreman should be held responsible for the water barrels on the bridges on his section, and should have stated times to see that the barrels are filled and that salt is added if needed. The bridge inspector, master carpenter and others whose duties require them to visit the bridges from time to time should also make a check to know that the section foremen are looking after them properly.

Climate Makes Difference

By Henry Becker
Section Foreman, St. Louis-San Francisco, Rush Tower, Mo.

Several factors affect the likelihood of water in barrels on bridges freezing during the winter months. Obviously, the most important of these factors is the climate of the locality. In the far south, no action may be necessary to protect against freezing; in the far north, these measures may be of prime importance. I have found that an excellent method of reducing the tendency to freeze is to bury the barrels in the embankment at the ends of the bridge, leaving the top from 4 to 6 in. above the level of the roadbed. In a heavy-snow country, further protection can be afforded by banking over the top with loose snow.

Early in the fall, before freezing weather sets in, the barrels should be filled and a sack of salt thrown in and thoroughly dissolved. If this is all taken up, enough more should be added to insure that the water has dissolved all that it will hold. In the area where I am located, this is sufficient to prevent the freezing of the water. In colder climates it may be necessary to use calcium chloride, because it requires a lower temperature to freeze a solution of this material than one of salt.

Each section foreman should be held responsible for the water barrels located on his section as it is his duty to make regular inspections.

Make Preparations Early

By L. A. Rape
Extra Foreman, Baltimore & Ohio, Wampum, Pa.

Sometime during the early fall, to insure that it will be done well in advance of freezing, the water barrels on bridges should be filled with clean water and enough salt, calcium chloride or other anti-freeze substance should be put in to insure that the solution will not freeze at the lowest recorded temperature for the particular locality.

If salt or calcium chloride is used, enough of it should be dissolved to provide a saturated solution. As a precaution, the water should be stirred thoroughly at intervals of several days for two or three weeks, and again when the temperature rises after a cold spell. Less of the salt or calcium is required to produce a saturated solution at low temperatures than when the water warms up, for which reason, agitation is needed to restore the condition of saturation when the temperature rises.

Responsibility for keeping the barrels filled and for inserting the anti-freeze material should be placed on the section forces, in connection with their routine duties. Others must make special trips to do this work.

Skylights and Ventilators

What attention should building forces take at this season to insure that skylights and ventilators are in proper condition for winter?

Should Be Overhauled

By Frank R. Judd
Engineer of Buildings, Illinois Central, Chicago

It is specially important that skylights and ventilators be inspected at this season, and that all defects found be repaired, to insure that they are in good condition to go through the winter. If skylight frames or ventilators are rusty, they should be cleaned and painted to protect them from further deterioration as a result of the destructive effects of certain kinds of weather.

If the caps have deteriorated beyond the point of reasonable repair, they should be renewed, and any broken glass should be replaced. It is also important to make a careful examination of the flashing around both skylights and ventilators, for leaks may occur as a result of the melting of snow piled up against them, which would not normally develop during summer or autumn rains. Where ventilators are equipped with dampers, these dampers should be examined to find whether they are in operative condition, so that they may be closed readily when desired.

Leaks Should Be Stopped

By H. H. Redlien
Draftsman, Pennsylvania, New York

At this season, while the weather is still favorable for making such repairs as may be found necessary, a thorough inspection should be made of all skylights and ventilators to locate any such defective conditions as leaks, faulty gutters, flashings, etc., and unprotected or corroded metalwork. If the skylights are of the puttyless type, care should be taken to screw down all capping on skylight bars, and any corroded metal found in any part of the skylights should be cleaned, scraped and thoroughly

painted. All broken glass should be replaced and all glass that is to remain should be well cleaned inside and out. It is most essential that condensation gutters be cleaned to insure good drainage for the condensation. If the skylights are of the type in which the glass is bedded in putty, all loose putty should be removed and replaced with live putty and then painted.

Ventilators should be inspected to insure that all flashing is in good condition to guard against leaks. If the ventilators are constructed of a material that requires painting to resist the action of the elements, they should also be painted.

First Find the Troubles

By General Inspector of Buildings

Before discussing the action that should be taken with respect to skylights and ventilators, it will be well to consider what troubles are experienced with them during the winter season. We will then know the particular items to search for when making our inspection.

Probably the most common troubles experienced with skylights are glass breakage and leaks. If the leakage occurs by reason of defective roofing or flashing, the remedy is obvious. However, flashing that seems to be in good condition and that has given no trouble during rain storms sometimes develops persistent leaks when snow that has piled up against it begins to melt. It is important, therefore, that the flashing be examined with particular care and that a thorough job of repairing suspicious places is done.

Glass breakage in skylights is not so simple, since it may be more the fault of design than of maintenance. Skylight glass should always be wire glass, and welded wire is better than the woven variety, since it can be made to coincide more nearly with the central plane of the glass. Experience has shown that under identical conditions there is less breakage where welded wire is used, as a result of extremes of temperature. Furthermore, as the angle of the glass with the horizontal decreases the rate of breakage of wire glass increases, most of the breakage from this cause occurring during rising temperature. Again, too many manufacturers skimp on the sections of the bars with a view to reducing and making original costs attractive. Skylights of this class are likely to be afflicted with heavy glass breakage as a result of excessive deflection under snow loads.

These are defects of design, however, over which the local forces have little control. Some improvement can be obtained by making sure that the felt pads or plastic bedding are in good condition and resilient, and that the holding bars are screwed down to the right tension to prevent leakage, but not so tight as to interfere with expansion and contraction of the glass. Obviously, all corroding metal parts should be cleaned and painted.

Besides the flashing, which is as important as in skylights, ventilators should be examined critically to insure that they are properly anchored. Dampers and the adjusting devices should be put in first-class condition, and all metal parts needing paint should be cleaned and painted.

Use of Pumpers' Daily Reports

What details should be included in a pumper's daily reports? Why? What use should be made of this information?

Information Approximate

By C. R. Knowles
Superintendent Water Service, Illinois Central, Chicago

As a rule, pumpers are required to make reports weekly or monthly, rather than daily, although a daily record is kept of certain details in connection with the operation of the pumping station. For example, daily records are kept of the amount of water used, of the number of hours the pump is run and of the amount of fuel and other supplies used. The reports submitted by the pumper should include a summary of his daily record of the amount of water pumped, the amount of fuel and lubricants consumed, and the quantities of other supplies used. In the space provided for remarks, the report should include information concerning the general condition of the equipment and the amount of fuel and other supplies on hand.

Relatively few pumping stations are equipped with meters or other devices for measuring accurately the amount of water pumped. For this reason, it becomes necessary for the pumper to determine approximately the quantity of water pumped into the tank. He can do this by observing the number of feet pumped into the tank, by recording the number of hours the pump is run or by counting the number of engines taking water. This information, compiled from the daily record, is incorporated in the weekly or monthly report.

Where water-treating plants are operated in conjunction with the pumping station, it becomes necessary that a record be kept of the amount of chemicals used. Where water-testing equipment is provided, a daily record should be kept of the tests made. As a rule, forms are provided upon which the pumper can enter a daily record of the amount of water pumped and of the quantities of fuel and other supplies used.

Separate forms are, or should be, provided to be forwarded weekly, together with samples of the treated water for analysis. These forms show the daily record of water treated, the kind and quantity of chemicals used and the amount of chemicals on hand at the close of the week. This practice is generally followed by those roads which have centrally located testing laboratories for the examination of the water samples, such records being necessary to insure that accurate information is available with respect to the conditions surrounding the operation of the treating plants.

Prefers Monthly Reports

By J. H. Davidson
Water Engineer, Missouri-Kansas-Texas, Parsons, Kan.

Primarily, the purpose of a pumper's report is to provide supervisory officers with accurate information concerning the volume of water pumped and treated, and to enable them to keep the station properly supplied with fuel and other essential supplies. The average pumper is not an expert bookkeper, for which reason the forms he is required to fill out should be made as simple as possible and still furnish the information necessary for the supervisor to have.

A daily record of the operation of the pumping station should be kept, but the work of doing this can be greatly simplified without decreasing its accuracy or effectiveness, by requiring the pumper to send the report in at the end of the month, instead of every day.

Essential information which should be required in these reports includes (1) the amount of fuel (coal, gas, fuel oil or gasoline) burned each day;

(2) the kilowatts of electric current used, or the meter reading; (3) the actual hours the pumps were operated; (4) the feet of water pumped into the tank; (5) the gallons of water pumped; (6) the quantity of waste and other supplies used; and (7) the quantities of various supplies on hand at the end of the previous month and the quantities received or shipped, giving dates. Items 3, 4 and 5, given separately as indicated, serve to check the pumper's figures with respect to the volume of water pumped.

If the pumper also operates the water-treating plant, similar information covering its operation and supplies may be included in the same report. It is preferable, however, to have a separate report, rendered weekly, covering in detail the operation of this part of the plant.

On page 955 of the 1929 edition of the American Railway Engineering Association Manual, is shown a form suggested for a pumper's daily report. This form can be adapted readily to meet any local conditions.

Protecting Poles from Fire

What methods should be employed to protect poles in telegraph and signal lines from fire when burning the right of way?

Cleans Grass in Advance

By O. H. Carpenter
Roadmaster, Union Pacific, Rawlins, Wyo.

I have found that the best method is to remove all grass, weeds or other inflammable material from around the poles ahead of the burning, the distance being governed by the amount of vegetation present. If the growth is heavy, the belt to be cleaned must be wider than if it is light. While burning the right of way, men should be assigned to watch the poles and extinguish any fire that may start in them. The throwing of dirt on them with shovels is usually effective, or water may be used if available. Usually, however, water must be hauled on push cars or trailers for some distance, involving the use of flag protection. This is not only costly but slow and it is my experience that dry dirt or sand is just as effective. If the growth is heavy and dry, good judgment dictates that attempts should not be made to burn the vegetation if the wind is strong. If it is calm or if only a light wind is blowing, poles will not catch fire if the ground around them has been cleaned for a distance of three or four feet.

Methods Vary

By Armstrong Chinn
Chief Engineer, Alton, Chicago

Where there is a normal stand of grass and weeds, and the poles are in reasonably good condition, no special precautions are necessary, as the section gang which does the burning and controls the fire can easily protect the poles from damage. If the vegetation is rank or the poles old and soft, and thus easily ignited, it may be necessary to clear the ground around them prior to burning the grass. The area to be cleared will depend on conditions, but usually a circle 10 to 15 ft. in diameter will suffice. Occasionally, owing to irregular terrain, the wires are carried so close to the ground that it may also be necessary to remove the vegetation beneath them to prevent damage from the flames, particularly those wires that are insulated.

Where lines are important and the vegetation is heavy, more permanent protection can be provided by removing the top soil within a radius of 5 to 10 ft. and piling it against the poles. This will destroy the vegetation for about a year, and the soil gives added protection. It is questionable, however, whether the saving in poles will justify the labor cost of clearing the ground.

Keep Fire Under Control

By W. E. Tilleti
Assistant Foreman, Chesapeake & Ohio, Maysville, Ky.

Of first importance when burning the right of way, the fire must be kept under control. This means that at any instant it must be confined to a relatively limited area. Otherwise, a sudden wind may fan the flames to such an extent that they may be entirely out of hand in a few minutes. When the mowing is done, all vines should be removed from poles and right of way fence; the cut grass should also be raked away from the poles at this time, since a chance spark from a passing locomotive may start a fire before the grass is generally dry enough to insure a clean job of burning. As this usually happens when the section gang is elsewhere, several poles may be damaged or destroyed before the men can get on the ground, unless a fire guard has been provided. Scalping a space around the poles still further reduces the fire hazard.

When the burning is started, one man should be assigned to watch the poles and extinguish any incipient fires that may start in them. This is particularly important if the line is old and the poles are decayed and becoming soft. The remainder of the gang should pay particular attention to preventing the fire from spreading to adjacent property or catching the fence posts.

Sand Gives Best Results

By A. L. Schalbrack
Section Foreman, Minneapolis, St. Paul & Sault Ste. Marie, Amherst, Wis.

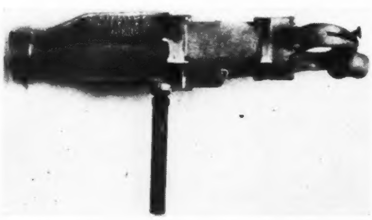
Sand or dry soil is most efficient in extinguishing fires that have started, and it has the advantage of always being available. But the objective should be rather to prevent than to put out fires. Here again, sand or clean soil is effective if piled around the base of the pole, about two generous shovels full being sufficient to prevent an ordinary fire from reaching a pole. In marshy ground or where the growth is quite heavy, it is better to mow around the poles and clean the grass away, because it takes too much dirt to act as a protection. Where there is a pole line on each side of the track, two men can complete 10 miles of this form of protection in seven hours. On my own section there are four pole lines and by using this method I have not had a pole burn during the last five years.

To fire the grass, I use a tightly bound roll of kerosene-soaked burlap fastened to the end of a 6-ft. wire. With this, one man on each side of the track, walking slowly, will fire an average of one mile of right of way an hour. The remainder of the gang follows with shovels to beat out any blaze that might otherwise get out of bounds. The burning should be done against the wind, starting at the right of way line where practicable, and the firing should not be advanced too rapidly or the fire may get out of control. Obviously, if both sides are burned at one time, one side must be burned toward the right of way line, but the foreman must exercise judgment and avoid any situation which may permit the fire to get over into adjacent fields.

New and Improved Devices

Powerful New Pneumatic Wrench

A POWERFUL pneumatic wrench, known as the Pott impact wrench, has been put on the market by the Ingersoll-Rand Company, New York, and has proved itself highly adapted to bridge construction, strengthening, and general repair work, wherever erection or assembly bolts must be used. The new tool, which employs a new principle in pneumatic tool design, is said to be more powerful than any other type of pneumatic wrench, making it particularly effective in drawing pieces tightly together, or in loosening and removing "frozen" nuts. At the same time, the new tool is relatively light in weight, and is said to be easy on the operator.

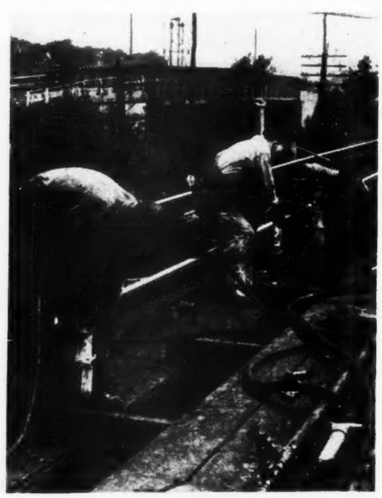


The New Pott Impact Wrench is Only About 20 In. Long and Weighs 22 lb.

The Pott impact wrench is approximately 20 in. long and consists essentially of a Multi-Vane air motor and the wrench unit. The latter consists of an accumulator, hammer and anvil, enclosed in a hammer case which is bolted to the air motor case. The wrenching chuck is attached to the anvil and extends outside the hammer case.

The new principle involved in the wrench lies in the accumulator, which is a cylindrical block of special rubber interposed between the Multi-Vane air motor and the chuck. In operation, the torque from the motor is applied to the accumulator, which, in twisting, shortens, lifting the hammer from engagement with the anvil. At a definite point in the twisting the energy stored up in the accumulator is released and the hammer is spun forward to the next engagement, thus delivering a powerful blow, with considerable mass behind it, to the anvil and, therefore, directly to the chuck of the wrench.

This action repeats itself at the rate of 1200 to 1400 times a minute, each time delivering a powerful torsional impact to the nut being tightened or loosened. When a nut runs free or with insufficient resistance to twist the accumulator and thus bring the impact feature into play, the nut is run up or backed off smoothly through constant contact through the wrench with the air motor. The speed of the wrench is approximately 700 r.p.m., which makes the application or removal of nuts a matter of seconds.



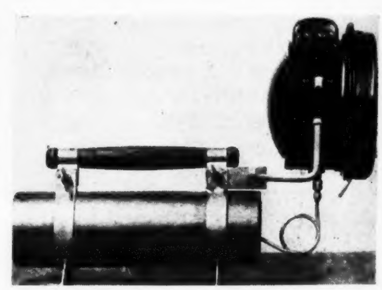
Three of the Pott Wrenches Being Used on a Deck Girder Cover Plate Job

The wrench, which weighs 22 lb., without the chuck, is operated readily by one man, and is practically devoid of torsional shock, the torsional impacts being absorbed within the accumulator. As the result of this cushioned action, it is said that there is no chance of injury to the operator, and, furthermore, that the wrench can be used on high places or in positions which might be unsafe with other types of wrenches.

The present models of the Pott wrenches, all of which are reversible, are recommended for work involving bolts from ⅝ in. to 1¼ in. in diameter. The chucks are made of alloy steel and can be had in a wide range of shapes and sizes.

Prest-O-Lite Motor Car Headlight

AN acetylene headlight for track motor cars, that can be used also as a portable night-inspection or trouble light is being distributed to the railroads by the Oxweld Railroad Service Company, Chicago. This new light should not be confused with the carbide type of light that is supplied with gas from an attached generator in which the gas is formed by the application of water to a charge of calcium carbide. In the new light, which is known as the Prest-O-Lite motor car headlight, the gas is fed from a small storage tank that contains a sufficient supply for 20 hours continuous burning, these gas storage cylinders being replaced as required. The gage built into the tank indicates the gas contents so that a new tank can be ordered in due time.



The Prest-O-Lite Headlight

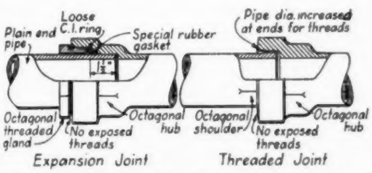
The light complete with cylinder weighs 16½ lb. and occupies a space 20 in. long, 9 in. wide and 13 in. high. The headlight, which has a

500-candle power lamp, is wind and weather proof and has reflectors which are said to be so designed as to have no "blind spot." As shown in the illustration, the lamp is supported from the cylinder which, in turn, is provided with brackets for fastening it to the motor car and also with a handle for ready portability.

New Hi-Test Cast Iron Pipe

THE Walworth Company, New York, is introducing a new form of cast iron pipe which it is designating at Walworth Hi-test cast iron pipe. It is adapted especially for underground water and air lines subject to severe soil conditions, and is supplied with threaded ends and special bottle-tight flexible expansion joints to facilitate laying and to care for expansion and contraction.

The new pipe, which is furnished in sizes ranging from 1¼ in. to 6 in. in diameter and in lengths of 5, 10, 15 and 20 ft., is cast horizontally under a patented process and employs a grade of iron which, while having strength and toughness, is soft enough to permit cutting and threading with either power or hand tools. The ultimate tensile strength of the iron is 35,000 lb. per sq. in., and minimum bursting pressures for the threaded pipe range from 7,000 lb. per sq. in. for the 1¼-in. diameter size to 1,500 lb. for the 6-in. size.



The Special Flexible Expansion Joint and the Standard Joint with Which the New Hi-Test Cast Iron Pipe Is Furnished

In the standard threaded joint furnished, the male end is enlarged in diameter before being threaded so that there is no weakening of the pipe by the threads. This screws into an internally threaded hub. Octagonal wrench grips are provided behind both the male threads and the hub so that joints can be made with open-end wrenches.

In the expansion joint, which it is recommended be used every 80 to 100 ft. to absorb expansion and contraction and any ground movement, the hub end is substantially the same as in the standard threaded joint, but the male end, instead of being threaded itself is fitted with a threaded gland with an octagonal wrench grip, which is drawn inward against a rubber gasket confined within the hub.

The Walworth standard threaded joint provides for making all joints above the ground and precludes all calking and the digging of bell holes. The expansion joint is usually made up in the trench, but requires no special work since it involves merely the drawing up of the joint gland with an open-end wrench. In addition to the threaded joints described, the pipe can be furnished, if desired, with flanged, plain, or standard threaded ends. Any of the pipe can be readily cut and threaded in the field for use with standard pipe size fittings.

Illinois Central Tests Wood Preservative

WITH a view to determining the possibilities of utilizing the supplies of inexpensive timber that are available along the lines of the Illinois Central, tests are being conducted on this road to ascertain the value of the Osmose process of wood preservation in the treatment of gum, lowland red oak and long and short leaf pine. The same process has also been employed recently on this road in an effort to extend the service life of the piles in an existing trestle, in which considerable decay had already taken place at and below the ground line.

The preservative used, which derives its name from the fact that penetration into the wood is secured through the process of osmosis, is unique in that it is applied to the pieces by hand with brushes. The compound consists of an acqueous paste comprising a preservative agent which penetrates the walls of the wood cells by osmosis, a protective agent which penetrates the wood to a lesser depth by capillary diffusion, a paste-forming colloidal substance and water.

Table I—Penetration in Inches at 30 Days

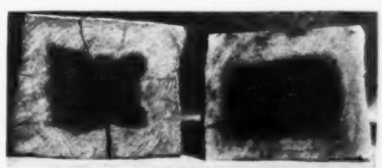
	Dinitro phenol (Protective Agent)	Sodium fluoride (Internal Preservative)
Red Oak Ties	⅜	¾
Red Gum Ties	5/16	1½
Pine Piling	⅜	1¾
Oak Piling	¼	¾

The preservative agent consists of sodium fluoride, a water-soluble inorganic salt, while the protective agent consists of dinitro phenol, an organic substance insoluble in water. The purpose of the latter substance, which penetrates only the outermost layers of the wood, is to provide a waterproof zone that will prevent the leaching out of the water-soluble preservative when the treated timber is exposed to rain or is placed in water or damp soil. The paste-forming colloidal substance dries on the surface of the wood and is designed to prevent the preservative from being washed off during the storing period.

The compound formed by the admixture of the above-mentioned ingredients is known as Osmolit and was employed on the Illinois Central in the treatment of green bridge timbers, piling and crossties. Another compound, known as Osmotite, which is identical with Osmolit except that potassium bichromate has been added, was employed in the treatment of the old piles at the ground line.

The timber selected for treatment with the Osmolit consisted of 48 red oak ties, 50 red gum ties, 6 pieces of pine piling 35 ft. long, 6 pieces of red oak piling 35 ft. long, 6 pieces of pine 7-in. by 16-in. by 28-ft. and 6 pieces of pine 14-in. by 14-in. by 14-ft. All these timbers were treated at Hammond, La., on December 4, 1934, within 24 hr. after being felled. The ties were hand hewn in the adjacent woods, while the piling was cut to size in the woods and hauled to the treating site where it was barked. The sawed timbers were trucked directly from the saw mill.

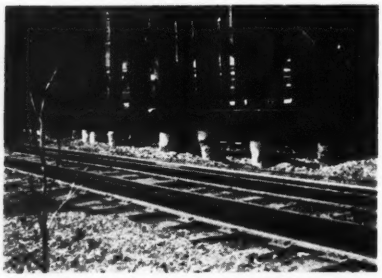
The treating compound was received in a dry powder form and mixed with water at the treating site to form a paste which was applied by hand with brushes to all surfaces of the timber. The amount of preservative applied was equivalent to ¼ lb. of the dry powder per cubic foot of wood treated. Following the application of the preservative, the timbers were stacked and covered with water-proof crepe paper to prevent the paste from being washed off by rain and to retard the drying of the wood before sufficient penetration of the preservative had taken place.


Two Crosstie Sections Which Have Been Treated With the Color Reagent in Order to Show the Depth of Penetration of the Osmose Preservative

Penetration Tests

Tests to determine how far the preservative had penetrated into the various pieces were made 30 days after the preservative had been applied. These tests consisted in taking increment borings from the various pieces

and of determining the penetration of the protective agent by visual inspection, this substance being yellow in color and readily seen, and of the preservative agent by use of the Alizarin color re-agent test. In this test the borings are placed in a solution of the color re-agent which stains the unpenetrated areas a deep red, whereas, wherever the sodium fluoride has penetrated into the wood in a concentration of 0.2 per cent the re-agent colors the wood yellow. The presence of the sodium fluoride in a concentration of 0.2 per cent is said to be sufficient to insure protection against fungi or fungi spore.



View Showing Some of the Decayed Piling That Were Treated With the Osmose Preservative.

Table I shows the penetration of the preservative and protective agents in the various pieces, as determined at the end of 30 days. Borings were not taken from the sawed timbers at this time.

Ninety days after the preservative was applied all but two of the ties were placed in the main line tracks of the railroad near Hammond, while the piling and other bridge timbers were inserted in a bridge located about 30 miles south of Jackson, Miss. A red gum tie and a red oak tie were shipped to the laboratories of the Osmose Corporation of America at Buffalo, N.Y., this company having secured the rights for using the Osmose process and Osmose preservatives in this country. In May, 1935, about five months after treatment, additional increment borings were taken from the piles and bridge timbers. The penetrations as determined from these borings are given in Table II.

Table II—Penetration in Inches in May, 1935

	Dinitro phenol	Sodium fluoride
Pine, 7 in. by 16 ft. by 28 ft.	3/4	2 1/2
Red Oak Piling	5/8	3
Red Oak Piling	7/8	2 1/2
Pine, 14 in. by 14 in. by 14 ft.	7/8	4 1/2
Long Leaf Pine Piling	1/2	3 1/2
Short Leaf Pine Piling	3/4	4 1/2
Short Leaf Pine Piling	3/4	4 1/2
Pine, 7 in. by 16 in. by 28 ft.	3/4	3 1/2
Piling, Red Oak	5/8	2
Piling, 7 in. by 16 in. by 28 ft.	3/4	2
Red Oak Piling	3/4	2 1/2
Long Leaf Pine Piling	7/8	3
Red Oak Piling	3/4	2 1/2
Red Oak Piling	3/4	4
Pine, 7 in. by 16 in. by 28 ft.	3/4	3 1/2
Pine, 7 in. by 16 in. by 28 ft.	7/8	3
Short Leaf Pine Piling	3/4	4 1/2
Pine, 7 in. by 16 in. by 28 ft.	7/8	2
Short Leaf Pine Piling	3/4	3
Pine, 14 in. by 14 in. by 14 ft.	3/8	2 1/2

The decayed piles that were treated form part of a trestle located at Chicago which, when constructed about seven years ago of untreated white oak, was intended as a temporary structure. When inspected recently the piles were found to be decayed at and below the ground line to a radial depth of more than an inch. To arrest this decay and to prevent further damage to the piling, the Osmose treatment was applied.

Treatment of Piles

In making the application the first step was to dig a hole about 2 ft. deep around each pile, after which increment borings were taken to ascertain the condition of the interior. After the decayed outer surface had been removed from those piling that warranted treatment, the preservative compound, Osmotite, was applied with brushes uniformly over a 36-in. section of each pile extending downward from a point 8 in. above the ground line. In order to protect the preservative from damage during the impregnation period, a bandage was wound spirally around the treated portion of each pile. The holes around the piles were then backfilled, which completed the operation. Of the 473 piles inspected, 357 were treated and 116 were rejected because of advanced decay.

About 90 days after the preservative was applied to the piles, test borings were taken to ascertain the depth to which the treating compound had penetrated. A total of eight borings, varying from 3/4 in. to 1 1/4 in. in depth were taken from various piles. In each case it was found that the preservative had penetrated to the full depth of the boring.

The tests on the preservation of the green timbers were carried out under the supervision of W. A. Summerhays, manager of the Forest Products bureau of the Illinois Central, while the treatment of the decayed piles was done under the direction of L. H. Bond, engineer maintenance of way of the railroad.

New Books

Wood Handbook

WOOD Handbook, prepared by the Forest Products Laboratory, Forest Service. 326 pages, 6 in. by 9 in. Illustrated. Bound in paper. Published by the United States Department of Agriculture. For sale by Superintendent of Documents, Washington, D. C. Price 25 cents.

Research in the properties of wood, its preparation for use and its behavior in service has made great strides during the present century, and the results of such research have been recorded in innumerable reports and monographs, as well as articles in technical magazines. But this book has been written to fulfill the need for a convenient compilation of the basic information concerning wood for the user who does not have the occasion or the facilities for an intensive study of any particular phase of the subject. The scope of the book is extensive rather than intensive. It covers the characteristics of the principal species, the general physical properties, strength values, and a glossary of technical terms. There are also chapters on grades and sizes, and on the various primary applications of wood, together with others on fire resistance, preservation, thermal insulation, moisture control, and structural details.

Railway Bridges

STEEL Railway Bridges—Concrete Railway Structures—258 pages, 6 in. by 9 in. Bound in cardboard. Published by the American Railway Engineering Association, 59 East Van Buren street, Chicago. Price $1.

To meet the growing demand for various specifications and recommended practices of the American Railway Engineering Association covering various classes of bridges and bridge work, the association has consolidated in one book such material from its Manual as would be of greattest immediate value to engineers, contractors, and vendors of construction materials.

Typical of the comprehensive specifications contained in this volume are those covering steel railway bridges, membrane waterproofing, movable railway bridges, bridge erection, turntables, concrete arches, concrete trestles, portland cement, concrete reinforcement and stone masonry. There is also included, such other material as rules for the classification of railway bridges, rules and unit stresses for rating existing bridges, methods of strengthing bridges, and principles for the design of flashing and drainage for waterproofing.

News of the Month . . .

Accidents Caused By Faulty Grade Crossings

That many highway-railway grade crossings, because of faulty construction and maintenance, present a hazard to safety and are a contributing factor in many accidents that take place at such crossings, is the contention in the annual report of the Committee on Grade Crossing Eliminations and Protection of the National Association of Railroad and Utilities Commissioners, which was presented at the annual convention of this association at Nashville, Tenn., on October 17. An important cause of accidents at highway crossings, according to the report, is a condition created by the washing away of the roadway material from the planking. With this condition prevailing, it continued, automobiles may be slowed down when the front wheels strike the obstruction and stalled entirely when the rear wheels reach the planking. Other undesirable conditions at grade crossings, according to the report, include steep and narrow approach grades and crossings that are narrower than the highway.

I.C.C. Organizes for Rule of Motor Carriers

The Bureau of Motor Carriers of the Interstate Commerce Commission, which has been created for the administration of the Motor Carrier act, will be a self-contained unit comprising 10 sections for carrying out the various phases of the work, according to a recent announcement of the commission. The new bureau will have sections in Washington dealing with Certificates and Insurance, Traffic, Accounts, Complaints, Finance, Safety, Research, Statistics, Legal and Enforcement Matters, and Administrative Matters. These sections will be supplemented by a field organization for the purpose of which the country will be divided into 16 districts with a separate organization, headed by a director, in each district. The Washington organization will be under the general supervision of an assistant director, and each section will be under the leadership of a chief of section. The commission had previously announced that it had selected John L. Rogers as director of the Bureau of Motor Carriers.

Rail Loan to New York Central Approved by I.C.C.

The Interstate Commerce Commission has approved the application of the New York Central for a loan from the Federal Emergency Administration of Public Works, the proceeds from which are to be used to finance the purchase and installation of 7,400 tons of new rail, with the necessary fastenings, at a cost of $386,000. The cost of labor in connection with the laying of the rail is estimated at $71,000, making the total estimated cost $457,000. In its application for approval of the loan, the railroad quoted figures to show that for the 8-year period 1922-29, the average amount of rail laid in replacement on its lines was 181,671 tons per year, while for the 5-year period 1930-34, the yearly average was 64,771 tons, a decrease of about 64 per cent. On the other hand, the average number of ton miles of freight hauled by the railroad during the two periods showed a decrease of about 33 per cent, or only about one-half the percentage decrease in the average number of tons of rails laid.

Air Traffic Increases

Scheduled air lines of the United States flew 28,729,128 miles, carried 377,339 passengers on air journeys totaling 162,858,746 passenger-miles, and transported 2,221,013 pounds of express in the first half of 1935, according to an announcement by the Bureau of Air Commerce, Department of Commerce. The figures for passenger, passenger miles and express totals comprise new records. In one previous six-months period the number of miles flown was larger—28,780,425, in the last half of 1933. The totals in the foregoing are for all routes, domestic and foreign extensions. The domestic routes flew 24,642,134 miles, carried 319,484 passengers, totaling 139,436,311 passenger-miles, and carried 1,412,969 pounds of express in the six-months period. On the foreign extensions, the totals were: Miles flown, 4,086,994; passengers, 57,855; passenger-miles, 23,422,435; express, 808,044 lb. At the end of the six-months period the 22 companies operating domestic routes and the 4 offering service to foreign nations were operating a total of 464 airplanes.

Rail Net Lower For Eight Months

For the first eight months of 1935 the Class I railroads of the United States had a net railway operating income of $263,738,184, which was at the annual rate of return of 1.66 per cent on their property investment, according to reports filed by the carriers with the Bureau of Railway Economics. In the first eight months of 1934, their net railway operating income was $302,872,358, or 1.89 per cent. Operating revenues for the first eight months of this year totaled $2,204,961,212, as compared with $2,188,633,354 in the corresponding period of 1934, an increase of 0.7 per cent. Operating expenses amounted to $1,698,631,063, compared with $1,631,865,537, an increase of 4.1 per cent.

For August these roads had a net railway operating income of $42,073,256, or 1.48 per cent, as compared with $40,564,075, or 1.42 per cent, in August, 1934. Operating revenues for August amounted to $244,017,777, as against $282,726,349 in the same month last year, an increase of 4 per cent. Operating revenues totaled $221,237,698, compared with $211,085,589 in the same month in 1934.

Expect Increase in Last Quarter Car Loadings

Freight car loadings in the fourth quarter of 1935 are expected to be about 6.4 per cent above actual loadings in the same quarter in 1934, according to estimates compiled by the 13 Shippers' Regional Boards. On the basis of these estimates, freight loadings of the 29 principal commodities will be 4,805,400 cars in the fourth quarter of 1935, compared with 4,515,835 cars actually loaded in the corresponding period last year.

Twelve of the 13 shippers' regional advisory boards estimate an increase in the loadings for the fourth quarter of 1935 compared with the same period in 1934, the only one expecting a decrease being the Trans-Missouri-Kansas board, which covers the states of Arkansas, Missouri and Kansas, and Northeastern Oklahoma. The largest increase expected is 31.3 per cent in the Great Lakes region.

Fletcher Stresses Importance of Railroads

Rail transportation bears an importance in the economic system of this country unequaled by any other form of transportation and is entitled to fair and equal treatment with its competitors, said R. V. Fletcher, general counsel of the Association of American Railroads, in a recent address at Chicago. Not only do the railroads furnish the cheapest form of transportation, but their importance as a means of investment, as a purchaser of goods, as an employer of labor and as a tax paying citizen cannot be ignored, he said. Mr. Fletcher pointed out that the railroads have never sought an unfair advantage over their competitors; on the contrary they are doing no more than "to proclaim their right to fair and equal treatment before the law, so that opportunity may be offered the American people to determine by actual experimentation just what is the place of the railroads in a transportation system operated with due regard to all elements of costs, by whomsoever these costs are paid." Referring to the Federal Barge Line, Mr. Fletcher pointed to the huge operating deficit that this government-owned project has incurred during the 17 years of its existence and said that "no greater service could be done than to abolish this grotesque and expensive experiment." Mr. Fletcher discussed the need for federal regulation of water lines; pointed out that taxes levied on the railways are relatively much heavier than on any other form of transportation; and predicted that "sooner or later, in accord with an inexorable economic law which tyrants and charlatans vainly strive to disregard, the people of this country will select the form of transportation which best serves their purposes."

Association News

Tie Association

The Railway Tie Association has resumed publication of the Cross Tie Bulletin after suspension for several months.

Maintenance of Way Club of Chicago

The Republican River flood and the resulting damage to the Chicago, Burlington & Quincy's line, together with the methods of restoration, provided the basis for a talk by H. R. Clarke, engineer maintenance of way, Chicago, Burlington & Quincy, Chicago, at a meeting held at the Auditorium hotel on October 30.

Wood Preservers Association

Members of the Executive committee met in Chicago on October 4 to complete details for the convention which will be held in Memphis, Tenn., on January 28-30. Suggestions for the program were approved. Plans are also under consideration to afford members of the association traveling from the north and east an opportunity to visit treating plants while they are enroute to the meeting.

Bridge and Building Association

Following the adjournment of the convention, members of the newly-elected Executive committee meet on the evening of October 17 to initiate preliminary plans for the new year. Among other measures, it was decided that President Strate will send a letter to members of the association promptly inviting volunteers for committee work. Chairmen of committees were selected as follows: Membership, C. M. Burpee; Finance, C. R. Knowles; and Hotel Arrangements, Elmer T. Howson. It was decided tentatively to hold the next meeting of the Executive committee in Chicago on December 14.

American Railway Engineering Association

The results of an outstanding example of railway research fostered by the association will go to the members within the next 10 days in the form of a report by J. B. Hunley, bridge engineer of the Cleveland, Cincinnati, Chicago & St. Louis, on Tests of Impact on Steel Railway Bridges of Simple Span, conducted on his railroad during 1931 to 1934, inclusive, which form the basis of a new formula for impact in the Specifications for Iron and Steel Structures, adopted by the association in March, 1935. This report, which covers 200 printed pages, will comprise the association's bulletin 380. Bulletins 378 and 379, containing revisions and additions to the Manual were mailed late in October.

The secretary's office is now receiving portions of the reports of committees to be presented at the convention next March and bulletins succeeding No. 380 will be devoted to the presentation of these reports, many of which are expected to be completed within a short time, since 15 committees met in October and 3 others are scheduled to meet in November. The committees that held meetings during the last month include Wood Preservation, at Chicago, on October 3; Iron & Steel Structures, at Philadelphia, Pa., on October 3 and 4; the Special Committee on Live Load and Impact, at Philadelphia, Pa., on October 4; Yards and Terminals, at Washington, D. C., on October 7 and 8; Records and Accounts, at Washington, D. C., on October 8; Ties, at Duluth, Minn., and St. Paul, on October 8 and 9; Standardization, at Washington, D. C., on October 9; Wooden Bridges and Trestles, at Chicago, on October 18; Economics of Railway Operation, at New York, on October 18; Ballast, at Washington, D. C., on October 18; Masonry, at Chicago, on October 23 and 24; Rules and Organizations, at Chicago, on October 25; the Special Committee on Economics of Bridges and Trestles, at Chicago, on October 26; and Economics of Railway Location, at Chicago, on October 29.

Meetings already scheduled to be held during this month include those of the committees on Shop and Locomotive Terminals, at St. Paul, Minn., on November 4 and 5; on Buildings, at Chicago, on November 7 and 8; on Waterways and Harbors, at Chicago, on November 12; on Track, at Chicago, on November 14; and on Economics of Railway Labor, at Columbus, Ohio, on November 20, which will be followed by an inspection of Norfolk & Western track and maintenance practices on November 21.

The Roadmasters Association

Recognizing for some time that the duties devolving upon the secretary have become too extensive to permit them to be handled "after hours," the Executive Committee, at a meeting held after the close of the last convention, arranged for the appointment of an assistant secretary to take over the duties of maintaining the membership list, collecting dues and publishing the proceedings and the bulletins. President Chinn has appointed to this position C. A. Lichty, who will give full time to this work jointly with that of the American Railway Bridge and Building Association, which latter organization Mr. Lichty has served as secretary for 27 years. Mr. Lichty will maintain offices as heretofore in Room 920, Chicago & North Western general offices, 400 West Madison street, Chicago. T. F. Donahoe will continue to serve the association as secretary, keeping the minutes of all meetings, etc.

Waterproofing Specifications—The Koppers Products Company, Pittsburgh, Pa., has issued a folder of 8½ in. by 11-in. sheets containing specifications covering the use of tar products for waterproofing grade separation structures. These embrace the materials such as waterproofing pitch, waterproofing fabric, waterproofing felt, etc., and also construction details, application and protection.

Personal Mention

Engineering

R. H. Stenhouse has been appointed division engineer of the Farnham division of the Canadian Pacific, with headquarters at Farnham, Que., succeeding **T. B. Ballantyne,** who has been appointed assistant district engineer of the Ontario district, with headquarters at Toronto, Ont., succeeding **George H. Davis,** deceased.

J. J. Desmond, division engineer on the Illinois Central at Chicago, who has been on a leave of absence because of ill health, has returned to his duties. **R. H. Carter,** who has been acting division engineer at Chicago during Mr. Desmond's absence, has returned to his former position of supervisor of track, with the same headquarters.

H. H. Pevler, division engineer of the St. Louis division of the Pennsylvania, with headquarters at Terre Haute, Ind., has been transferred to Ft. Wayne division, with headquarters at Ft. Wayne, Ind., succeeding **R. H. Crew,** who has been transferred to the New York division at New York, to replace **J. F. Swenson,** who has been transferred to the Logansport division at Logansport, Ind. Mr. Swenson succeeds **C. O. Long,** who has been transferred to the St. Louis division to replace Mr. Pevler.

Track

M. L. Wheatley, a track foreman on the Illinois Central, has been promoted to supervisor of track, with headquarters at Central City, Ky., succeeding **J. Pruitt,** whose death is noted elsewhere in these columns.

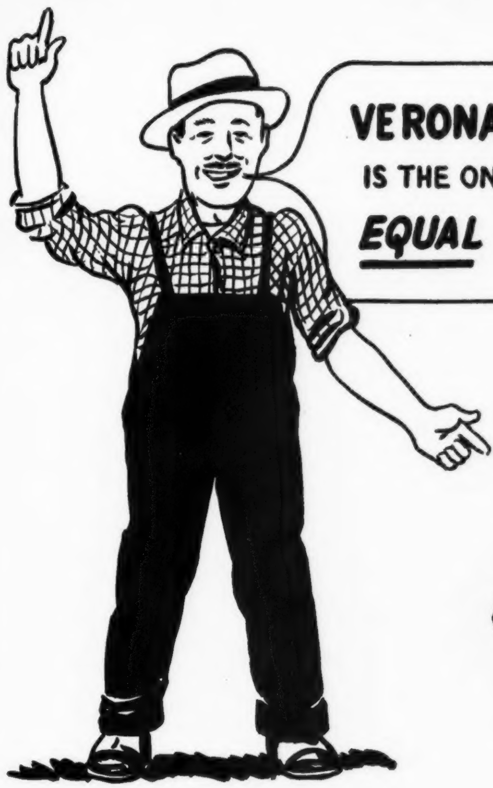
J. A. Larkoski, a yard foreman on the Chicago, Milwaukee, St. Paul & Pacific, has been appointed roadmaster, with headquarters at Madison, S. D., to succeed **T. McGee,** deceased.

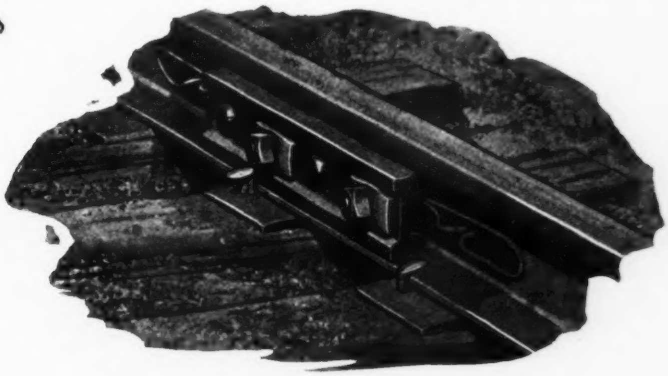
P. I. Buser, a track inspector on the Chicago, Rock Island & Pacific, has been promoted to roadmaster, with headquarters at Iowa Falls, Ia., to succeed **H. M. Long,** who has been transferred to Cedar Rapids, Ia., to succeed **John McNulty,** who has retired.

W. B. Earthman has been appointed track supervisor on the St. Louis-Louisville division of the Southern, with headquarters at Huntingburg, Ind., succeeding **F. S. Cooper,** who has been transferred to Princeton, Ind., to replace **L. B. Craig,** whose appointment as bridge and building supervisor is noted elsewhere in these columns.

W. A. Nichols, a bluff gang foreman on the Missouri-Kansas-Texas, has been appointed roadmaster, with headquarters at San Antonio, Tex., to succeed **J. C. Hill,** who has resigned to accept a position in the operating department of the

(Continued on page 706)





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is the only device on the market developing proper and equal bolt tension and providing a means for maintaining this tension.

Verona Triflex Spring exceeds the American Railway Engineering Association specifications for spring reaction by 100 per cent.

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SINCE 1873

WOODINGS–VERONA
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SINCE 1873

Green Bay & Western. Mr. Nichols was born on September 10, 1891, at Ashland, Mo., and entered railway service in February, 1916, as a laborer on the Missouri-Kansas-Texas. Two years later he was promoted to section foreman at New Franklin, Mo., which position he held until May 7, 1927, when he was further advanced to roadmaster, with headquarters at Parsons, Kan., being transferred to Boonville, Mo., on December 1, 1928, and thence to Denison, Tex., on December 23, 1931 Mr. Nichols was reappointed section foreman on May 15, 1932, and served in this position and as bluff gang foreman until his recent promotion to roadmaster.

F. H. Lewis, supervisor on the Philadelphia division of the Pennsylvania has been transferred to the Williamsport division, with headquarters at Milton, Pa. **F. R. Shultz,** supervisor on the Middle division has been transferred to the Wilkes Barre division, with headquarters at Reading, Pa. **M. S. Smith** has been appointed assistant supervisor on the Philadelphia division, with headquarters at Harrisburg, Pa. **E. P. Adams,** assistant supervisor on the Philadelphia division has been transferred to the Delmarva division, with headquarters at Clayton, Pa. **P. D. Fox,** assistant supervisor, with headquarters at Tyrone, Pa., has been transferred to the Middle division, with headquarters at Altoona, Pa. **F. W. Artois,** supervisor, with headquarters at Reading, has been transferred to the Williamsport division, with headquarters at Williamsport, Pa. **F. H. Pflaging,** supervisor, with headquarters at Middletown, Pa., has been transferred to the Philadelphia division, with headquarters at Columbia, Pa. **A. M. Kennedy,** assistant supervisor on the Middle division has been appointed assistant supervisor on the Maryland division, with headquarters at Wilmington, Del. **D. E. Smucker,** supervisor on the Delmarva division has been appointed acting supervisor on the Maryland division, with headquarters at Perryville, Md. **L. A. Evans,** assistant supervisor on the Middle division, has been appointed acting supervisor on the Delmarva division, with headquarters at Clayton, Del. **L. W. Green,** assistant supervisor on the Baltimore division has been appointed acting assistant supervisor on the Middle division, with headquarters at Lewistown, Pa. **J. C. Skinner** has been appointed acting assistant supervisor on the Baltimore division, with headquarters at York, Pa.

Bridge and Building

J. C. Schneider, bridge and building foreman on the Victoria division of the Southern Pacific Lines in Texas and Louisiana, has been appointed acting bridge and building supervisor of the same division, with headquarters at Victoria, Tex., succeeding **C. N. Billings,** who has been transferred to the Dallas-Austin division, with headquarters at Ennis, Tex., to replace **J. D. Kelly,** who has been transferred to the San Antonio division, with headquarters at San Antonio, Tex., where he will have jurisdiction over the west end of the division. **C. Black,** bridge and building supervisor on the San Antonio division, with headquarters at San Antonio, hereafter will confine his duties to the east end of that division.

L. B. Craig, track supervisor on the Southern, with headquarters at Princeton, Ind., has been appointed bridge and building supervisor, with the same headquarters, to succeed **E. Veith,** who has been transferred to Louisville, Ky., to succeed **J. B. Teaford,** who has been retired.

S. P. Jakeman has been appointed bridge and building master on the Canadian National, with headquarters at Edmonton, Alta., succeeding **D. M. MacKenzie,** who has been transferred to Calgary, Alta. **M. J. Wylie,** bridge and building master, with headquarters at Saskatoon, Sask., has been transferred to Port Arthur, Ont., to succeed **D. Campbell,** who has retired.

Obituary

J. Pruitt, supervisor of track on the Illinois Central, with headquarters at Central City, Ky., died on September 28.

T. McGee, roadmaster on the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Madison, S. D., died on September 22.

Charles S. Sample, principal assistant engineer of the Missouri Pacific, with headquarters at St. Louis, Mo., died on September 25 at the age of 62 years. Mr.

Charles S. Sample

Sample was born on June 1, 1873, at Philo, Ill., and was educated in civil engineering at Purdue University from which he graduated in 1899. For two years after leaving college, Mr. Sample was connected with the Chicago & Northwestern, then going with the St. Louis Valley (now part of the Missouri Pacific). For a short time, beginning late in 1903, he was with the Dalhoff Construction Company on railroad construction in the South and after leaving this company he went with the Missouri Pacific as assistant engineer. In this capacity, Mr. Sample served at various points on the system and was in charge of double-tracking the Illinois division and of rebuilding the yards at Hoisington, Kan. He served also as resident engineer in charge of construction of the cut-off between Memphis, Tenn., and Marianna, Ark., and then served for five years as chief pilot engineer for the Missouri Pacific on valuation inventory by the Interstate Commerce Commission. In 1921, Mr. Sample was appointed construction engineer, and while in this capacity, he had charge of various heavy construction projects, including the double-tracking of the main line between St. Louis, Mo., and Jefferson City at a cost of $22,000,000, and the revision of grades and alinements of the Kansas-Colorado main line at an expenditure of $7,000,000. Since 1932, he has had the title of principal assistant engineer.

Harold Toms, bridge and building master on the Canadian National, with headquarters at oMntreal, Que., was drowned on August 25 while on a fishing trip on the St. Lawrence river.

H. O. Sinsabaugh, roadmaster on the Chicago, Rock Island & Pacific, with headquarters at Montreal, Que., was October 10, as the result of injuries incurred in a motor car accident that took place on July 13.

W. A. Clark, supervisor of track on the Reading, with headquarters at Trenton Junction, N. J., died at his home in Trenton on September 30, following intermittent illness for several months. Mr. Clark, who was born on June 1, 1876, in Delaware County, Pa., entered the service of the Reading as a clerk at Jenkenstown, Pa., in May, 1895. In September, 1898, he was appointed assistant supervisor of track at Trenton Junction, and in August, 1900, was transferred in the same capacity to the Germantown & Norristown branch. In May, 1902, he was promoted to supervisor of track on the Germantown & Norristown branch, and on October 20, 1905, he was appointed supervisor on the main line at Trenton Junction.

Roland P. Eubank, general real estate agent of the Chesapeake & Ohio, with headquarters at Huntington, W. Va., and formerly connected with the engineering department of this company, died of heart disease on October 14 at Richmond, Va. Mr. Eubank was born on November 14, 1880, in King William county, Va., and attended Virginia Polytechnic Institute. He entered railway service in October, 1905, as a rodman for the Carolina, Clinchfield & Ohio (now Clinchfield), later becoming assistant engineer. In December, 1909, he became assistant engineer in the construction and real estate department of the Chesapeake & Ohio, and in February, 1916, he was appointed assistant real estate agent. Mr. Eubank was promoted to real estate agent in March, 1920, and general real estate agent in April, 1927.

Inland 4-Way Floor Plate—A 60-page letter-size folder describing and illustrating its new light pattern 4-Way floor plate has been issued by the Inland Steel Company, Chicago. The folder also discusses in a general way the two other patterns of 4-Way floor plate that are manufactured by this company.

(Supply Trade News on page 708)

Supply Trade News

General

Joseph T. Ryerson & Son, Inc., recently completed a new extension to the company's plant at Jersey City, N. J., making available an additional 45,000 sq. ft. of floor space for the stocking of steel and allied lines.

The Republic Steel Corporation, Youngstown, Ohio, has moved its Pittsburgh district sales office from Fourth and Bingham streets to 1832 Oliver building, Pittsburgh, Pa. The **Union Drawn Steel Company,** a Republic subsidiary, has moved into an adjoining suite in the Oliver building.

Personal

Roger Q. Milnes and **S. C. Johnson** have been appointed assistants to the vice-president of the **Dearborn Chemical Company,** Chicago.

Muscoe Burnett, Jr., assistant division manager of the **Linde Air Products Company,** with headquarters at Chicago, has been appointed assistant sales manager

Muscoe Burnett, Jr.

of the **Oxweld Railroad Service Company,** with the same headquarters. He was born in Paducah, Ky., and was educated at the University of Virginia. Since leaving college in 1920, he has been associated continuously with various units of the Union Carbide & Carbon Corporation, of which the Oxweld Railroad Service Company is one. His first connection in 1920 was with the Oxweld Acetylene Company and four years later he was transferred to the export department of the Union Carbide Company, later going to the Linde Air Products Company, where since 1929 he has been assistant division manager at Chicago.

Jules A. Morland has been appointed technical representative in South America, with headquarters at City Hotel, Buenos Aires, Argentina, of the **Timken Roller Bearing Company,** Canton, Ohio.

Edward L. Ryerson, Jr., was elected vice-chairman of the board of the **Inland Steel Company** at a meeting on September 30. The action follows the recent consolidation of Joseph T. Ryerson & Son, of which he was president, with Inland.

In connection with the consolidation of the production and sales activities of the **Carnegie Steel Company,** the **Illinois Steel Company** and the **Lorain Steel Company,** subsidiaries of the **United States Steel Corporation,** under the name of the **Carnegie-Illinois Steel Corporation,** the following officers have been appointed: **I. Lamont Hughes,** formerly president of Carnegie, is executive vice-president; **C. V. McKaig,** formerly vice-president and general manager of sales of Carnegie, is vice-president and general manager of sales; and **J. E. Lose,** formerly vice-president of Carnegie, is vice-president in charge of operations. All of the above officers will maintain offices in both Pittsburgh, Pa., and Chicago. **G. Cook Kimball,** formerly vice-president of Illinois, is vice-president and chief executive of the Chicago district; **William I. Howland, Jr.,** formerly vice-president and general manager of sales of Illinois, is vice-president in charge of western sales, both with offices in Chicago; **L. H. Burnett,** formerly vice-president of Carnegie, is vice-president at Pittsburgh; and **Carroll Burton,** formerly president of the Lorain Steel Company, Johnston, Pa., is vice-president in charge of the Lorain division. **J. W. Hamilton,** formerly secretary of Carnegie, is secretary; **William Donald,** formerly auditor and assistant secretary of Carnegie, is auditor; and **H. E. Jeffries,** formerly treasurer of Carnegie, is treasurer. As noted in the October issue **Benjamin F. Fairless** has been elected president of the new company.

Obituary

Frank J. Johnson, one of the founders of the American Hoist & Derrick Company, died on October 15, at the age of 79.

George Slate, vice-president and a director of the Simmons-Boardman Publishing Company, publishers of the Railway Age, *Railway Engineering and Maintenance* and other railroad and technical periodicals, and business manager of Marine Engineering & Shipping Age, and the Boiler Maker & Plate Fabricator, died on September 26, at Overlook hospital, Summit, N. J., at the age of 61 years. Mr. Slate was born on September 27, 1874, at Oxford, Mich. and was educated in the public schools of Alma and Grand Rapids, Mich. He started his business career in the classified advertising department of the Philadelphia Press, later removing to New York, where he served with the New York Journal in a similar capacity. His association with Marine Engineering has extended over a period of about 34 years, he having joined the staff of that publication as an advertising salesman on October 14, 1901. He was later elected a vice-president of the Aldrich Publishing Company, which at that time published that periodical. In 1905, the company acquired the Boiler Maker and Mr. Slate's jurisdiction was extended to include that journal as well as Marine Engineering. In 1920 the Aldrich Pub-

George Slate

lishing Company, with its two publications, was acquired by the Simmons-Boardman Publishing Company and shortly thereafter Mr. Slate was elected a director of the latter company.

C. W. Kelly, secretary-treasurer of the **National Railway Appliances Association,** Chicago, died in that city on October 19, following an operation for the removal of gall stones. He was born in Sullivan, Ind., on August 5, 1870, and after graduating from Purdue University in 1891 with the degree of civil engineer, was associated with the World Columbian Exposition. In 1893, he entered the employ of the Chicago & North Western as a draftsman and after holding various positions was appointed superintendent of bridges and buildings in 1901. He held the latter position until 1907, when

C. W. Kelly

he resigned to become a representative of the railroad department of Fairbanks, Morse & Co., where he was later promoted to assistant sales manager. In 1912, he resigned to organize the Kelly Derby Company with which company he continued as president until his retirement in 1925. In 1909, he was elected secretary-treasurer of the National Railway Appliances Association.

STATEMENT of the ownership, management, circulation, etc., required by the Act of Congress of March 3, 1933, of RAILWAY ENGINEERING AND MAINTENANCE, published monthly at Chicago, Ill., for October 1, 1935.

State of Illinois} ss.
County of Cook}

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared E. T. Howson, who, having been duly sworn according to law, deposes and says that he is the editor of the RAILWAY ENGINEERING AND MAINTENANCE and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Simmons-Boardman Publishing Co., 30 Church St., New York, N. Y.
Editor, E. T. Howson, 105 West Adams St., Chicago, Ill.
Managing Editor, Walter S. Lacher, 105 West Adams St., Chicago, Ill.
Business Manager, F. C. Koch, 30 Church St., New York, N. Y.

2. That the owners are:

Simmons-Boardman Publishing Company, 30 Church Street, New York, N. Y.; Simmons-Boardman Publishing Corporation, 30 Church Street, New York, N. Y.; Stockholders of 1 per cent or more of the total amount of stock are: I. R. Simmons, 15 Hillcrest Dr., Pelham Manor, N. Y.; P. A. Lee, Hopatcong, N. J.; Henry Lee, Hopatcong, N. J.; E. G. Wright, 398 West Walnut Street, E. Orange, N. J.; S. O. Dunn, 105 West Adams Street, Chicago, Ill.; C. E. Dunn, 3500 Sheridan Blvd., Chicago, Ill.; L. B. Sherman, 375 Sheridan Road, Winnetka, Ill.; Mae E. Howson, 105 West Adams Street, Chicago, Ill.; Spencer, Trask & Company, 25 Broad Street, New York, N. Y. General partners of Spencer, Trask & Company are: E. M. Bulkley, Acosta Nichols, Cecil Barret, C. Everett Bacon, William R. Basset, F. Malbone Blodget, Henry S. Allen, Henry M. Minton, William Kurk Beckers, Arthur H. Gilbert, all of 25 Broad Street, New York, N. Y. Percival Gilbert, William E. Stanwood, both of 50 Congress Street, Boston, Mass., are General Partners, Henry A. Colgate, 25 Broad Street, New York, N. Y., Special Partner, and S. Bayard Colgate, Special Partner, 15 Exchange Place, Jersey City, N. J.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. T. HOWSON,
Editor.

Sworn to and subscribed before me this 30th day of September, 1935.

ANNE A. BOYD.
[Seal] (My commission expires Dec. 10, 1935.)

ALPHABETICAL INDEX TO ADVERTISERS


AGE
RED-LEAD
CAN TAKE IT!
. . . and there's no
better RED-LEAD
than DUTCH BOY